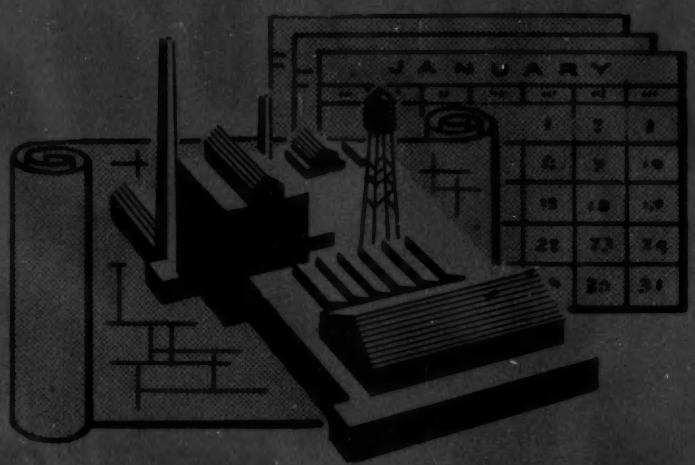
SAE Journal

MAY 1956



Annual Production Issue

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Type "98" oil ring—
U.S. patent numbers
2,635,022 and 2,695,825

more than

1/2*

of the

7,943,969 passenger cars produced in the U.S. in the year 1955 were equipped with

PERFECT CIRCLE

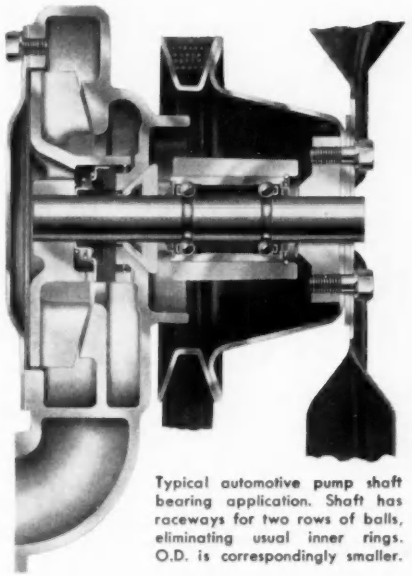
Type "98" Oil Chrome Rings

* 52% were Perfect Circle's new Type "98" Chrome Oil Rings.
48% were all other oil ring types combined, including other Perfect Circle oil ring types

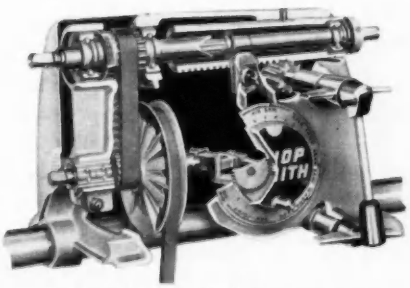
FACTS

about

NEW DEPARTURE
BALL BEARINGS



Typical automotive pump shaft bearing application. Shaft has raceways for two rows of balls, eliminating usual inner rings. O.D. is correspondingly smaller.



Integral shaft of bearing serves as intermediate shaft in Magna's "Shopsmith". Assures fewer parts, easier machining, more accurate, quicker assembly.

For each McCulloch Mower, New Departure provides two pump shaft bearings with hollow shafts to permit vertical adjustments. Special heat treating gives full hardness at the raceways but adequate toughness in the shaft to withstand hard service.

FAN AND PUMP SHAFT BEARING IS ADAPTABLE TO MANY USES!

This sealed and "lubricated-for-life" bearing with integral shaft was originated by New Departure specifically to simplify automotive fan and water pump mounting. Since its inception, it has reduced bearing maintenance requirements to virtually zero in millions of car, truck and other engines.

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The manufacturer of a well-known power tool, which combines several tools in one compact unit, employs the pump shaft bearing as a complete intermediate shaft with pulleys on one end and a keyway for tool attachment on the other, with obvious design and performance advantages.

Another manufacturer produces a power mower in which two of these versatile NEW Departures with hollow shafts not only support the mower rotors, but permit vertical adjustment of the wheel spindles to regulate cutting height.

So here is another NEW Departure adaptable to many uses. New Departure engineers can show you what it and other ball bearings will do to improve your products.

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Address inquiries to: Emmett E. Hearn, Employment Director, Box 179, Dept. E3, Denver, Colorado

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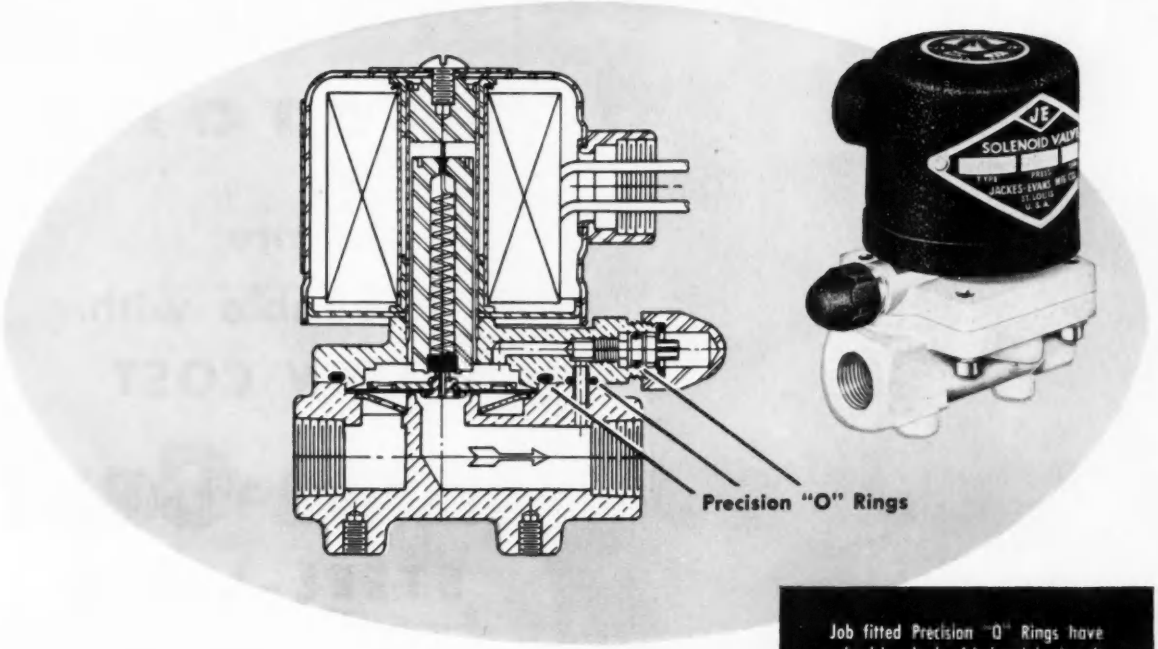

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Precision "O" Ring compound 233-70 was developed especially for refrigerant service. It is used in the solenoid valves manufactured by Jackes-Evans Company of St. Louis, Mo. This compound assures the right chemical resistance and low temperature flexibility required for uninterrupted, maintenance free operation of refrigeration equipment using Freons.

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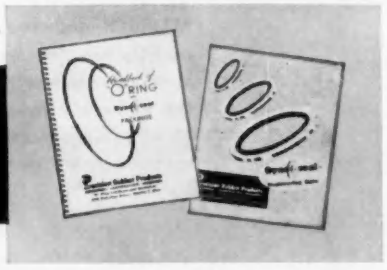

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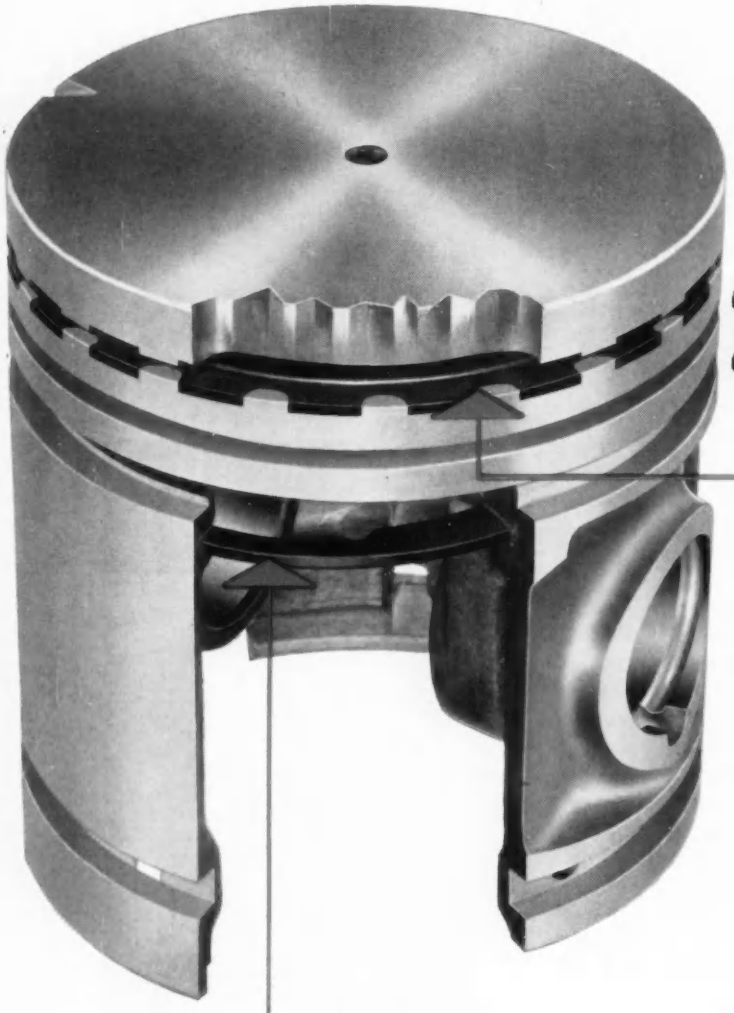

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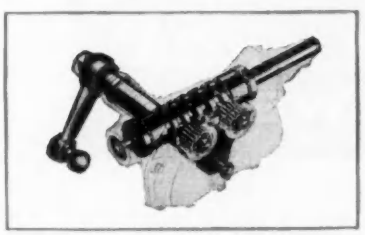

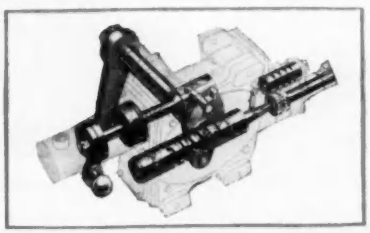

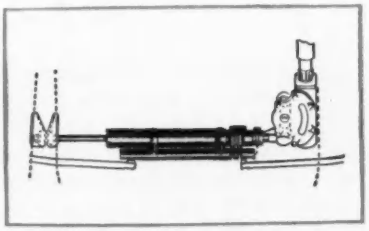

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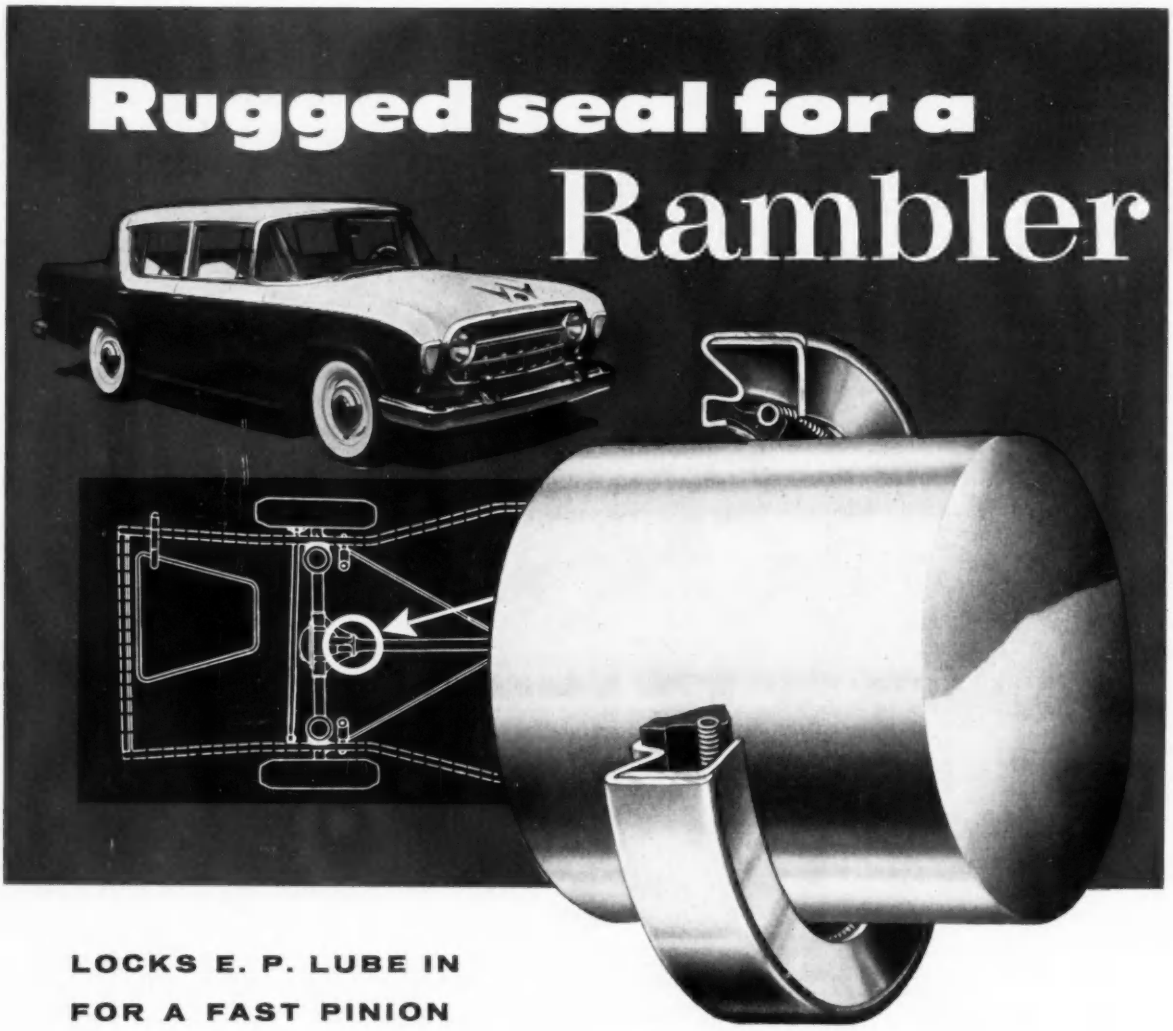
Rugged seal for a Rambler



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AP 265-45

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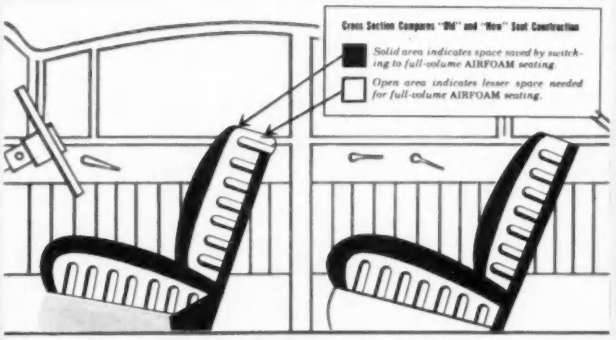
But **TODAY'S** high style is too <u>low</u> for wasted space


Cross Section Compares "Old" and "New" Seat Construction
Solid area indicates space saved by switching to full-volume AIRFOAM seating.
Open area indicates lesser space needed for full-volume AIRFOAM seating.

So **AIRFOAM** saves space, saves style, saves sales with new **R-0-0-M** **for comfort!**

STYLE TRENDS can reach a point where there's hardly room for a customer to get at his wallet! Then it's time to make more room for *people*—and their buying urges.

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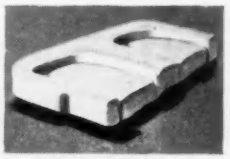
THESE NEW AIRFOAM SEAT-UNITS are smartly—but comfortably—modern and, seemingly magically, provide more headroom, footroom, elbowroom, kneeroom — BUYING ROOM! To get the facts on very latest developments, contact Goodyear, Automotive Products Department, Akron 16, Ohio.

AIRFOAM makes interiors roomier, more luxurious



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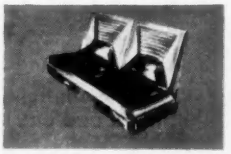

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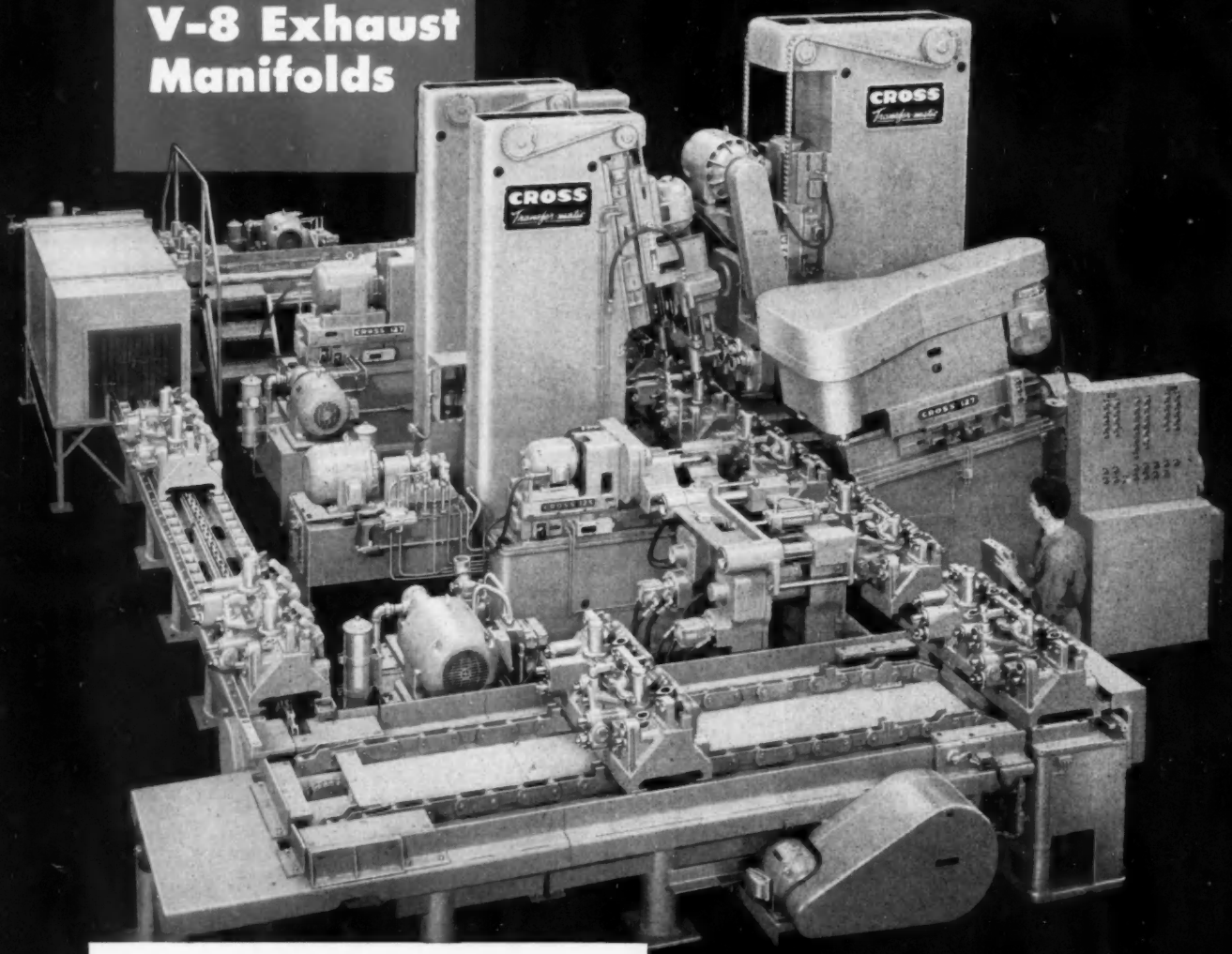

- ★ 51 operations: 8 milling; 37 drilling, chamfering and spotfacing; and 6 tapping.
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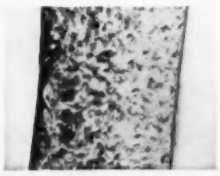
NATIONAL MICRO-TORC* LEATHER OIL SEALS



How Micro-Torc works—Side of chrome retanned leather lip is coated with dry lubricant and elastomer. Elastomer binds lubricant to leather, prevents seepage through leather, enhances mechanical stability—yet permits leather's natural porosity to remain in body of sealing lip. Lip actually stores oil for dry or emergency running!

For applications where temperatures are within —50° to 200° F, maximum shaft speed is 2,000 fpm, and runout is held to about 0.005", new National Micro-Torc oil seals should definitely be investigated.

The Micro-Torc sealing member is perhaps the most interesting advance in leather oil seals in 15 years. In hundreds of thousands of hours of actual application, Micro-Torc seals have consistently shown up to 80% less torque and 10 times the life of other leather seals. Breakaway torque is normally only 20% of conventional leather seals, and Micro-Torc seals have operated up to 100 hours dry at 1,350 rpm without sloughing or squealing. Properly used, Micro-Torc seals provide positive sealing throughout service life.

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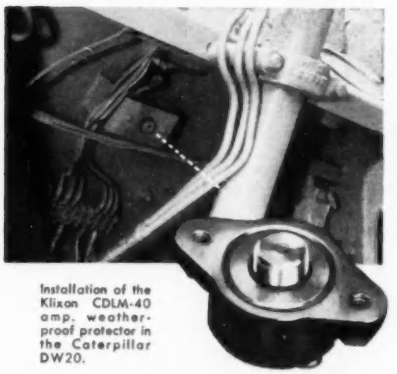
No matter what type of mobile equipment you operate or how severe the operating conditions, it will pay for you to use Klixon Breakers for sure, permanent circuit protection in 6, 12, or 24 volt systems. Compact, they are easy to install. Their operation is unaffected by shock, motion, vibration, dust or moisture. Write for information.



Installation of the Klixon CDLM-40 amp. weatherproof protector in the Caterpillar DW20.

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For the Sake of Argument

Thought and Action—A Mighty Mix

By Norman G. Shidle

"Isn't it amazing how many right approaches there are to almost every problem?", a philosopher friend averred the other day.

"No matter how right your program or plan, the next fellow often has one equally good. . . . But to evaluate, you must look at *his* plan through the facts and the environment from which it sprang."

Not everyone agrees with my friend. But everyone knows that an infinite number of lines lead from the circumference of a circle to its center. Similarly, people may come to the same truth through many different routes. Certainly, each is stirred to start on his march by different notes of different bugles.

But, say dissenters, no doctrine is less likely to lead either individuals or groups to a center, a truth . . . or to active execution of *any* plan. So full consideration of the potentials of all, they contend, may lead more to long-winded debates than to forward movement . . . to comfortable contemplation than to achieving action. Some folks will even stop to concern themselves over the plans which might have been developed but weren't!

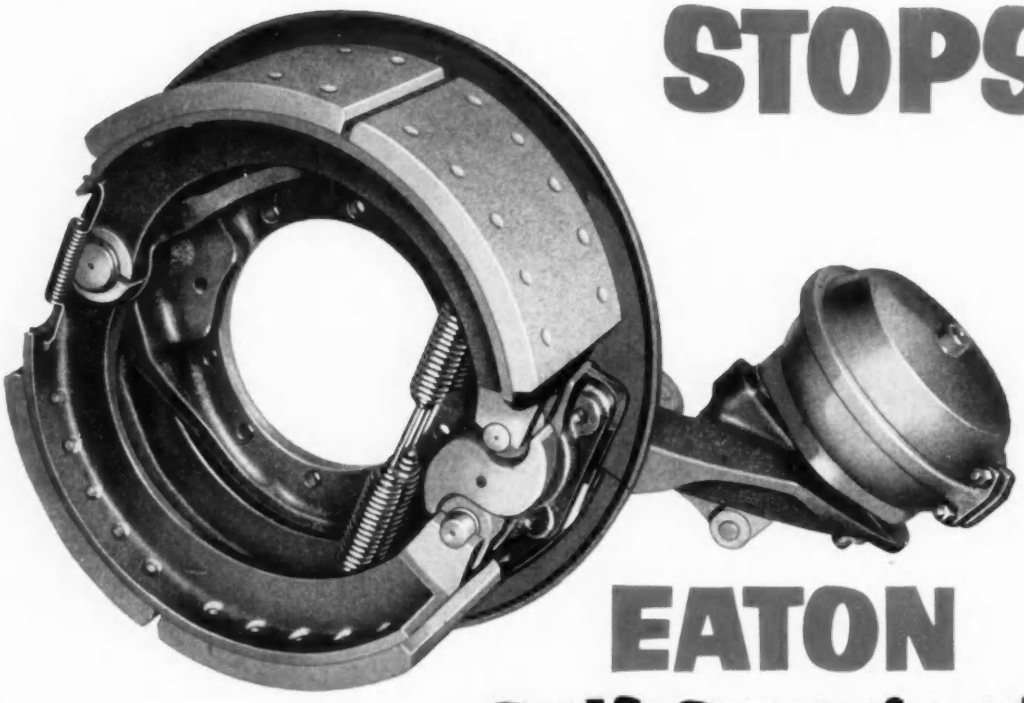
Perhaps, they argue, 'twere just as well that philosophers be not kings—at least in the realm of everyday administrative action.

In this debate, as always, there is probably much to be said on both sides. "The truth about most things is gray—a mixture of black and white. . . ."

To recognize the existence of alternate plans; to evaluate those sufficiently gelled for examination within reasonable limits of time . . . these steps will appeal to most as wisdom. To transfer thinking from a sitting to rising posture before drowsiness sets in will seem advisable, too.

No business problem requires a nicer sensitivity than spotting the point where discussion should stop and action begin. Yet it faces almost everyone almost every day.

for QUICKER, SAFER STOPS-



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In addition to quicker, safer stops, Eaton's advanced design provides a number of other important benefits. Floating split-shoe design—using a single pin at the anchor ends, with rollers and floating pins at the cam ends of the shoes—eliminates the need for anchor pin lubrication, and prevents pin seizure. Simply constructed with fewer parts, over-all weight is reduced approximately 15 per cent. Relining is quick and easy, cutting labor as much as two to four hours.

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President

John A. C. Warner
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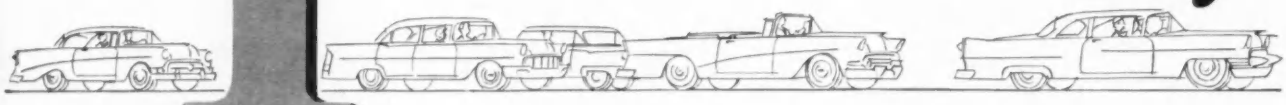

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Manufacturing men are

PLANNING *for* TOMORROW

They are facing tomorrow's problems today and meeting the challenge by planning for

*** New Machines**

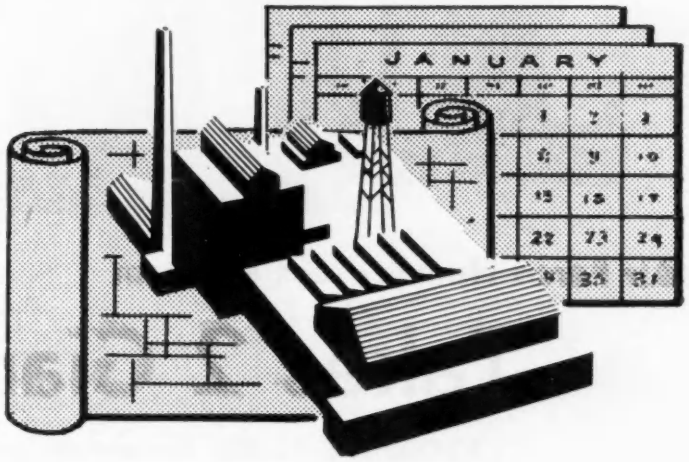
to fabricate more precise, more complicated products faster and cheaper than ever before.

*** New Methods**

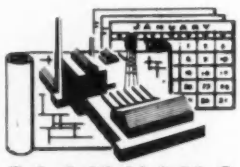
and manufacturing processes to cope with tough-to-fabricate materials that are being designed into new products.

*** Better Human Relations**

to achieve better coordination and communication between men in the shop and those in engineering and management.



What manufacturing men are **PLANNING FOR TOMORROW,** how they are meeting the challenge of the future, will be discussed in the articles of this issue.



PLANNING
for
TOMORROW

Air Force Heavy Press Program

Takes 2 Giant Steps

50,000 and 35,000 ton presses are forging larger, more precise, light-metal parts for future aircraft. Here's what's been happening during the first year's operations.

ONE year ago this month a touch of a button put the two giant heavy presses at the new $40,000,000 Air Force-ALCOA plant in Cleveland into operation. Since then great strides have been made toward the ultimate goal of forging entire aircraft sections in one piece.

These two mammoth presses, 50,000 and 35,000 tons, are now producing larger, more precise light metal forgings than ever before. Precision forgings mean stronger, lighter, and less expensive structural parts for all types of aircraft. The presses' large forging areas are permitting the design of one-piece airframe parts which formerly required several pieces. Precision obtainable through the 35,000 and 50,000 tons of forging pressure is reducing previous requirements for expensive machining, too.

For instance, if a part previously made on a 15,000-ton press is forged by the 50,000-ton press, over three

times the unit pressure is available to form the metal. This increase in pressure can be used to force the metal throughout the die and attain thin ribs and webs. Also, draft angles can be designed so small that there is no need to machine the excess metal off.

Thus a new class of forgings—precision forgings—has been born. While they may cost more to produce, they are often more economical in the long run since they require less machining and assembling afterwards. Also, precision forging design proportions can be reduced approximately 50% without lowering strength/weight ratios appreciably.

These large presses are also making possible the use of light metal forgings for a number of new applications. Wing beam carry-through fittings, shown in Fig. 1, previously had to be assembled from three forgings. Now they can be made in one piece, as shown in Fig. 2, thereby reducing weight without losing strength.

Wing beams consisting of upper and lower caps integral with the webs can be made. Essentially, they are structural I-beams which run from the base of the wing to its tip, tapering off in cross-section toward the end of the wing. Forgings can taper the section to conform to the tapering depth of the wing, as well as reduce the cross-sectional area of the caps of the I-beam as required by the reduced bending load near the outboard end.

The giant presses can forge sections of the wing skin with structural stiffeners or ribs forged as part of the skin. These sections, shown in Fig. 3, can be forged integrally with the rather thick pads required for efficient attachment of the wings. This part must be a precision forging, and the maximum capacity of the 50,000-ton press is taxed to provide panels of adequate area even for fighter aircraft. This type of forging is probably the closest approach possible at present to the concept of forging entire aircraft sections at one time.

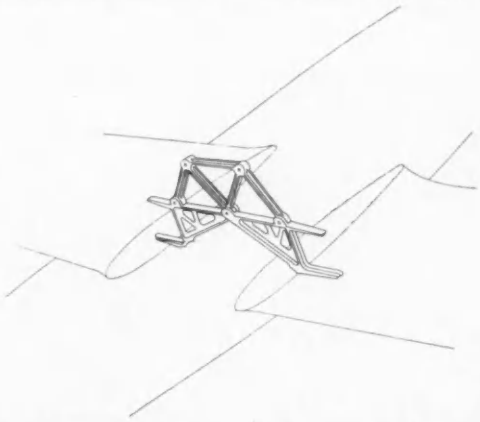


Fig. 1—World War II aircraft used a wing beam carry-through which had to be assembled from three forgings. Other parts had to be riveted together from sheet, plate, castings, and forgings—all of which increased costs and weight.

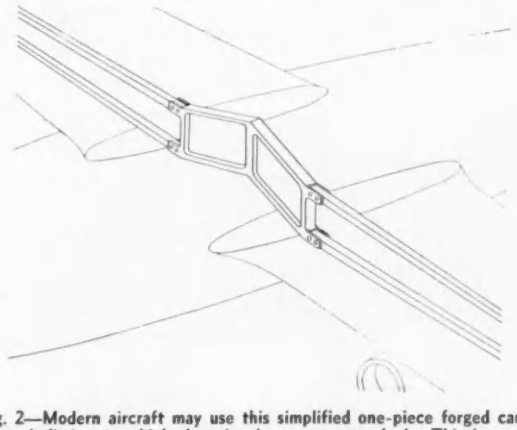


Fig. 2—Modern aircraft may use this simplified one-piece forged carry-through fitting to which the wing beams are attached. This is one of many new designs made possible by the heavy presses at the Air Force-Alcoa Cleveland Plant.

A Picture Tour

TOWERING nearly five stories above floor level, the two giant presses dominate all other equipment in Alcoa's half-million square feet plant. Probably what impresses visitors more than anything else—three busloads of SAE members toured the plant recently—is the immense amount of equipment that exists only to support these two behemoths.

Large furnaces heat aluminum billets before forging; others heat-treat the forgings after they have been hot worked. There are presses for straightening and bandsaws for trimming the forgings. Cranes of all types and sizes, lift trucks, and animal-like manipulators handle and transfer the billets and forgings. Batteries of scientific testing equipment check the forgings for quality. All have been integrated to provide an efficient production line into and out of the heavy presses.

About two-thirds of the total area of the new heavy press plant is devoted to the production of the vital forging dies. Six million dollars of die sinking machinery make sets of die blocks for each design of forging. The dies are ground and polished by skilled workmen by hand. For the complete die-to-finish story of a heavy press forging, turn page.

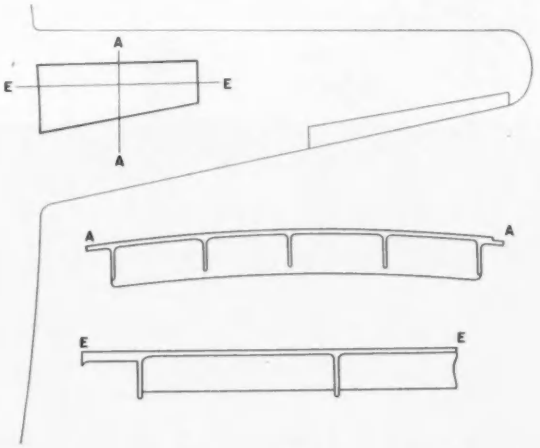
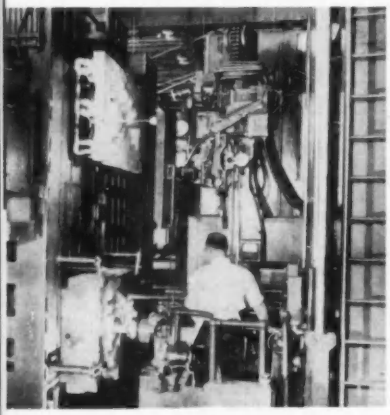
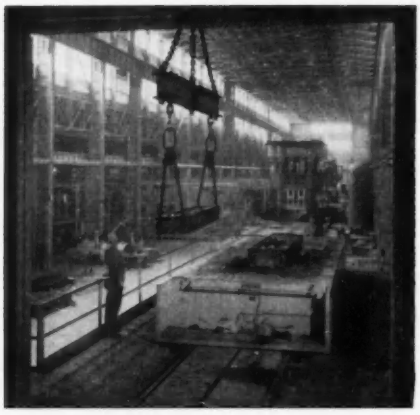


Fig. 3—Giant presses can forge integrally-stiffened wing skin panels such as this. The ribs are forged as part of the skin and they impart necessary stiffness without increasing weight appreciably.

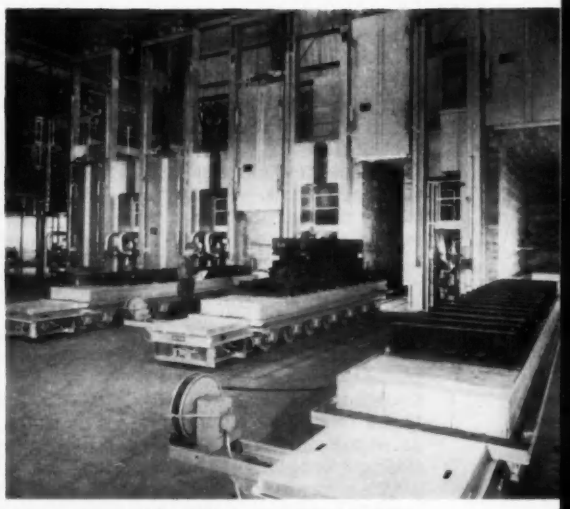
SAE Visits Giant Presses



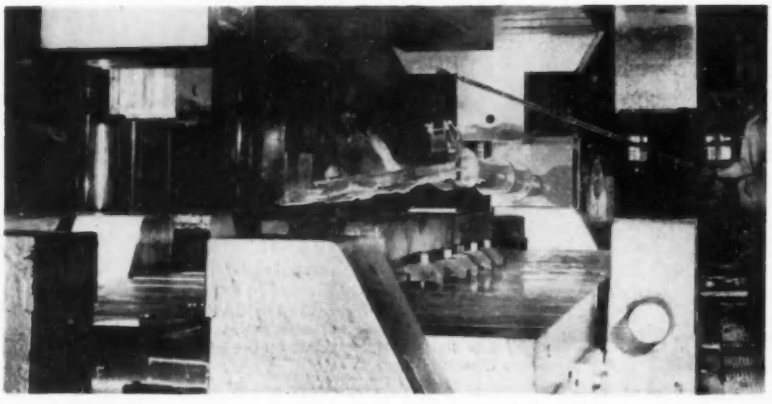
1. DIE-SINKING machine cuts the forging impression into a die block. A metal finger traces contours of a forging's plaster model. . . .



2. FINISHED DIE is carried from the die shop to the main press bay by a 100-ton electric trolley. A 200-ton crane picks it up and takes it to the die storage yard. Die blocks may weigh as much as 25 tons. . . .

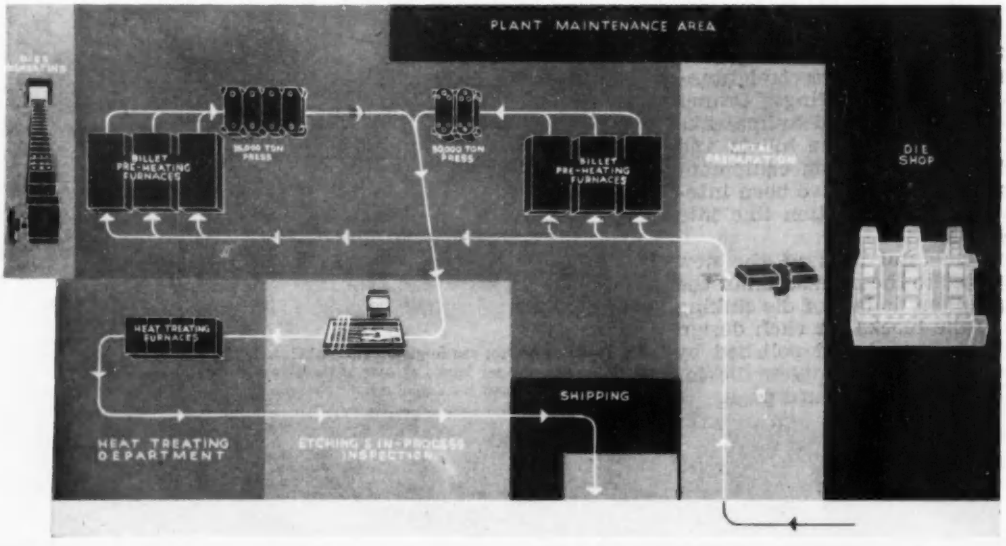


3. FIVE FURNACES pre-heat the dies to prevent their cooling the metal during forging. Both heavy presses have power-operated die runout tables to facilitate die changing. In the meantime metal ingots are cut to size on large saws or machine tools. . . .



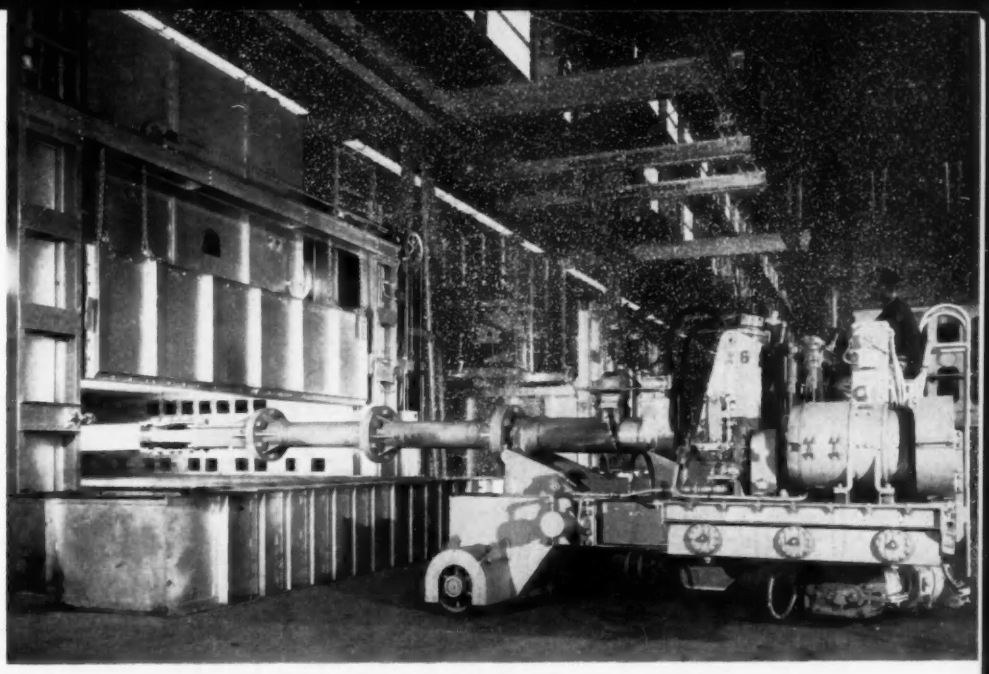
5. FORGING usually requires two steps: The billet is blocked into the general shape. Then the forging is trimmed, straightened in a small press, and surface defects are removed by etching. After reheating it is reforged. (Above) Workmen lubricate the dies through long spray pipes. . . .

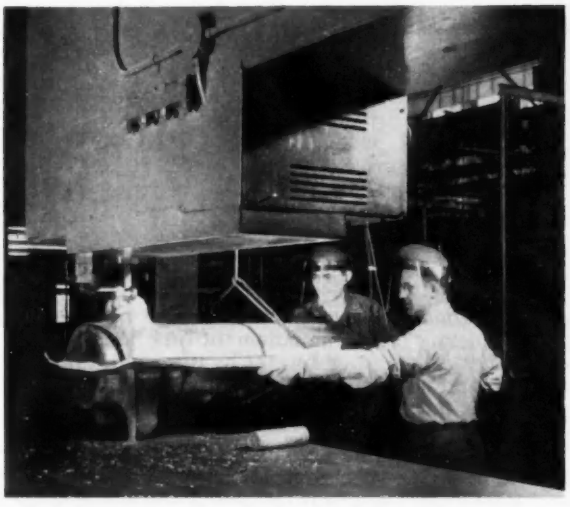
6. CHECKING the forging's measurements as soon as it is removed from the press insures a high degree of precision. . . .



9. OPERATIONS flow logically through the Air Force Heavy Press plant. The entire plant, which has 12 acres of floor space under its roof, was built to feed the two mammoth forging presses. It is part of the Air Force's $279,000,000 Heavy Press Program intended to increase the production capacity of the U. S. aircraft industry. . . .

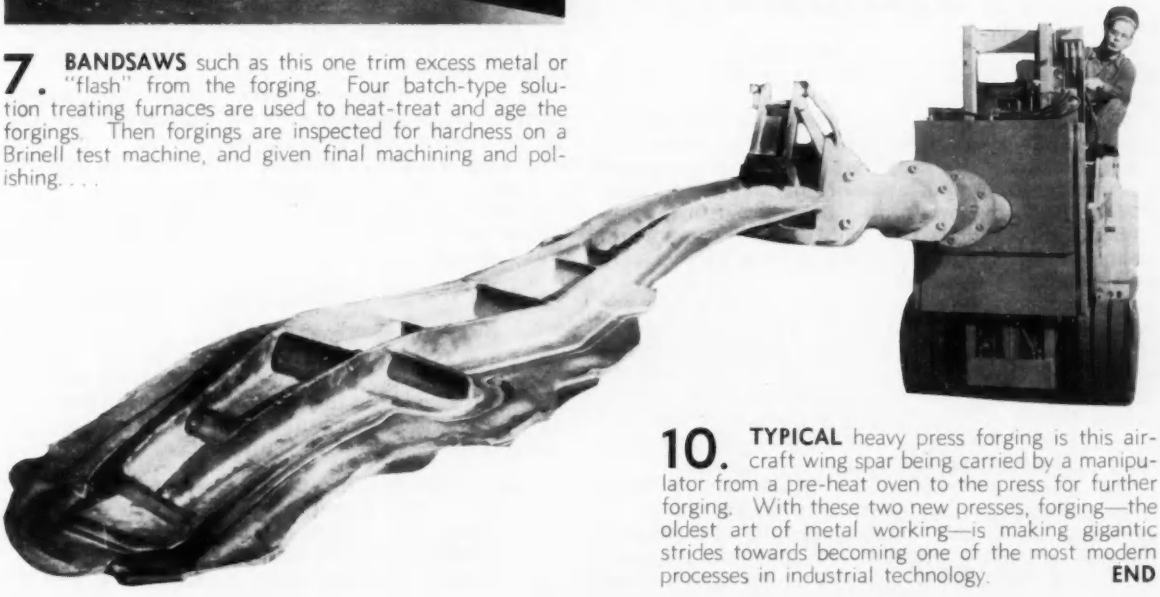
4. BILLETS ARE HEATED in one of three continuous heating furnaces. As they emerge from the slat-type conveyor hearth, they are picked up by a manipulator which carries them to the bed of the press and places them in the forging dies. . . .





8. ULTRASONIC inspection machine tests for any subsurface flaws in the forging. Black light inspection is used to detect surface cracks. . . .

7. BANDSAWS such as this one trim excess metal or "flash" from the forging. Four batch-type solution treating furnaces are used to heat-treat and age the forgings. Then forgings are inspected for hardness on a Brinell test machine, and given final machining and polishing. . . .



10. TYPICAL heavy press forging is this aircraft wing spar being carried by a manipulator from a pre-heat oven to the press for further forging. With these two new presses, forging—the oldest art of metal working—is making gigantic strides towards becoming one of the most modern processes in industrial technology. **END**

From Books

Training the College for Future

TO INSURE an adequate supply of technical and nontechnical **leaders for tomorrow** in industry, proper indoctrination and training of college graduates is now a necessity.

Business and industry are faced with a continuing shortage of technical graduates. It is estimated that 24,000 engineering students will graduate in 1956 against an estimated demand ranging from 40,000 to 60,000.

The shortage of graduates with management potential, both technical and nontechnical, is an equally pressing problem.

While indoctrination and training procedures, however effective they may be, cannot eliminate these shortages, the fact that the supply is limited accentuates the importance of effective indoctrination and training programs. Such programs, properly planned and carried out, offer an important means of seeing that the available supply is used with maximum effectiveness.

The basis for developing and implementing a sound program for the indoctrination and training of college graduates is a sound overall personnel program for the entire organization. People—all the people who make up the organization—are the deciding factor. They spell the difference between success and failure in an enterprise, give one company a competitive advantage over another.

The transition from school, where the emphasis is on directed development, to industry, where the emphasis is on self development, is the primary objective of indoctrination and training programs for college graduates. In setting up the training program consideration must be given to the growing complexity of the management function. Training activities, whether formal or informal, must be selected and used with a view to preparing the graduate to fit into an increasingly more complex work environment.

Training programs are most effective when tailored to meet the specific needs of both the graduate and his employer. Such programs will contain the right balance—the right mixture of formal and informal content.

When the college graduate enters industry he wants a real job—wants to feel that he is putting his previous training to productive use. He also wants opportunity—opportunity for growth and development and advancement.

Some of the techniques and devices that are effective in the orientation and training of college graduates include:

- On the job training, planned and supervised.
- Job rotation, planned movement to provide not only experience on specific jobs but also to aid in providing general knowledge of the organization—its personnel, functions, facilities, and processes.
- Formal training in conference or classroom type situations can be used effectively for indoctrination purposes—acquainting the graduate with company history, policies, business objectives, or-

to Business

Graduate Leadership in Industry

L. E. Howell, General Motors Corp.

Based on secretary's report of panel on Indoctrination and Training of College Graduates for Manufacturing held as part of the SAE National Production Forum, Cleveland, March 19, 1956.

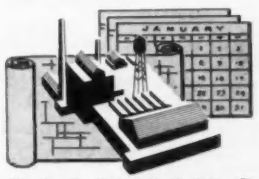
ganization, and such. Also to accomplish training in such areas as human relations, labor relations, work standards and methods, quality control, and cost control.

- Presupervisory and other management training in formal programs.
- Coaching and counselling—by immediate supervisors, program supervisors, advisors, and such.
- Assignment to committees—especially to special study or working committees.
- Participation in conferences.
- Participation in outside activities—such as community projects and professional societies.
- Use of staff assignments to broaden knowledge of organization, processes, and the like.
- Use of advanced trainees as substitute foremen.
- Use of training laboratories—where representative processes, methods, and equipment are used under actual manufacturing conditions.
- Assignment of reports during training period.
- Frequent appraisal of performance and progress during training period. Discussion with trainee. To be used by management as a basis for mapping future assignments for the trainee.
- Use training program as aid in determining future placement.

Discussion

How can we make supervisors in the line organization good trainee instructors?

This is a problem of proper selection. Emphasis should be placed on selecting supervisors who have the ability to deal with people. Then emphasis should be placed on giving the supervisor adequate



PLANNING *for* TOMORROW

On the Panel . . .

THE MATERIAL on the indoctrination and training of college graduates contained in this article is based on a panel discussion by the following men:

Panel Leader:

E. L. Yates,
Director, College Relations and Technical Employment,
General Motors Corp.

Panel Secretary:

L. E. Howell,
Central Office Personnel Staff,
General Motors Corp.

Panel Members:

A. E. Bach,
Director, Placement,
Case Institute of Technology

C. G. Eschenbach,
Director, Industrial Relations, DeSoto Division,
Chrysler Corp.

John Gehling,
Assistant Works Manager,
White Motor Co.

G. E. Moore,
Manager, University Relations,
Westinghouse Electric Co.

D. F. Neubauer,
Director, Industrial and Public Relations,
Brown-Lipe-Chapin Division, General Motors Corp.

R. A. Seekely,
Engineering Senior,
Case Institute of Technology

The men on the panel consist not only of men who have been working with the problem at hand, but also a recent college graduate and a future college graduate.

training and assistance in discharging this part of his responsibility.

Some engineering graduates prefer staff or technical assignments to manufacturing supervision. How should this training be handled?

Their training should be adapted to the particular situation. All trainees should not be subjected to the same program.

Are grades a good indicator of a graduate's future value?

Grades are one of several factors to be considered. Probably as good as any single indicator we have, but by no means conclusive. Positive correlation between grades and success has not been demonstrated.

Are we giving too much emphasis to training technical graduates for production?

Technical graduates should be placed where their specialized training can be used most effectively. This does not necessarily mean that they should be assigned to production. Their assignment should be governed by the particular situation—the individual involved and the nature of the need.

What kind of responsibility can and should be given to a graduate trainee?

The exact nature or degree of responsibility given a trainee is not of prime importance. The main thing is to put the trainee in a situation where he can rightly feel that he is contributing, that is, belongs to a team where he is a productive member.

How can the schools help bridge the gap between school and industrial responsibility?

Some of the things which can be done are:

—Encourage undergraduates to obtain summer employment.
—Encourage school instructors to obtain summer employment in industry.
—Have industrial men talk to student groups.
—Plan student plant visitations.

What can be done to insure continued interest and development between the end of the training period and the end of the first five years of employment?

This is a crucial period. However, the graduate should not be singled out for special attention. The graduate's progress should be followed closely after completion of his orientation training, he should be given further training, adequate coaching, and guidance, but these things should be done within the framework of a sound overall personnel program which applies to all employees.

(The report on which this article is based is available in full in multilith form together with reports of the six other panel sessions of the 1956 SAE National Production Forum. This publication, SP-314, can be obtained from SAE Special Publications Department. Price: $1.50 to members, $3.00 to nonmembers.)

INTEGRATING AUTOMATION & DESIGN

or

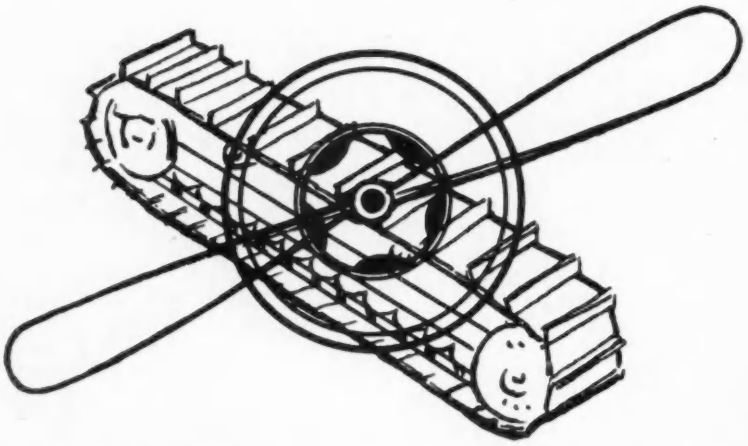
AWAKE AT THE SWITCH

(A Management Satire in Two Acts)

This is an edited transcript of the actual dramatization presented at the SAE Annual Meeting, Detroit, January 10, 1956 ..... A synopsis and backstage news story of this event appeared in the February issue of SAE JOURNAL pp. 84–85.

Cast of Characters

EXECUTIVE VICE PRESIDENT, Helitrac Corp.	**A. T. Colwell,** vice-president, Thompson Products, Inc.
MANUFACTURING MANAGER, Helitrac Corp.	**L. I. Woolson,** president, DeSoto Division, Chrysler Corp.
CHIEF ENGINEER, Helitrac Corp.	**E. N. Cole,** chief engineer, Chevrolet Division, General Motors Corp.
DIRECTOR OF PURCHASING, Helitrac Corp.	**F. E. Farrell,** director of automotive sales, Bendix Products Div. Bendix Aviation Corp.
SALES MANAGER, Helitrac Corp.	**C. L. Hecker,** first vice-president, Oliver Corp.
THE VENDOR	**D. D. Robertson,** vice-president in charge of sales, Dana Corp.



"Wherever a propeller spins, wherever a track crawls, wherever a wheel turns—it's a Helitrac!"

ACT ONE

TIME: *Present*

SCENE: *Executive conference room of the Helitrac Corp., manufacturer of the Helitrac, a combination automobile, tractor, helicopter. Through a large window up center can be seen the Helitrac factory. A movie screen is available for those executives who wish to illustrate their reports with slide pictures. Before the skit begins a copy of the following memo is distributed to the audience as well as to the cast.*

Helitrac Corporation
Inter-office Letter

From: A. T. Colwell

To: C. L. Hecker, sales manager
L. I. Woolson, manufacturing manager
F. E. Farrell, director of purchases
E. N. Cole, chief engineer

Subject: Policy meeting on integration of design and automation, Tuesday, Jan. 10, 1956

There will be a meeting on Jan. 10, 1956 at 1:00 p.m. to discuss vital questions concerning sales, engineering, manufacturing, and purchasing policies.

The situation of our company has deteriorated within the last few months to an alarming extent. Drastic steps have to be initiated to reverse the trend of decreasing sales and vanishing profits. Revised designs and advanced manufacturing techniques are needed to revitalize the business of this company. At the meeting, latest financial data will illustrate the serious situation of our company.

We have a versatile product, useful in many fields. Sales should be prepared to discuss the reasons for our declining business, suggested improvements and new fields for our product.

Manufacturing should present recommendations for improved manufacturing methods, particularly cost savings through automating some of our operations.

Engineering should present a general idea for a new power plant with improved performance that can be economically produced.

Purchasing should recommend purchasing policies to lower the cost of the Helitrac.

Very truly yours,
A. T. Colwell,
Executive Vice President

The executive vice president enters, followed by the sales manager, manufacturing manager, director of purchasing, and chief engineer. They sit down at a long conference table, take various papers from their brief cases, and make themselves comfortable. The vice president pours himself a drink of water from a carafe on the table, then begins the meeting.

VICE PRESIDENT

(*Looking to see that all are present*) You gentlemen all received my memo about a month ago. The company is deteriorating very rapidly. In 1953 we had sales of $375,000,000. $300,000,000 in 1954 and $225,000,000 in 1955. We had a profit of $28,000,000 in 1953, $4,500,000 in 1954, and we're in the red this last year $800,000. Now we've got to do something about this. We've got a good vehicle. There's no reason why we can't keep up with our competition. We're hired by the stockholders to run this company and we've got certain obligations. We're practically the only industrial concern in this vicinity and we've got several thousand employees. Instead of laying off labor we ought to be hiring more. We have a responsibility to the community. We have a responsibility to return a profit for the money our stockholders have invested. We have paid 7 or 8 dollars a share in the past. Last year we paid 50¢ a share, and we had to dig into the reserve to do it. Now unless we do something about this we're going to find ourselves out of jobs. The stockholders don't like investing in a non-profit organization. You've all had a chance to think about this since you received my memo. Carl, what's your opinion of our sales situation?

SALES MANAGER

Arch, I've prayed two years for this opportunity to get this group together and really tell them the true picture. You say that we have a good vehicle. But you ought to hear what the people out in the field say.

VICE PRESIDENT

Well, that's what we're here for: What's wrong with the Helitrac?

SALES MANAGER

It's 40% underpowered. Fuel consumption 18% greater than in the foreign made Vamp; as far as weight is concerned, they are 16.8% less than we are; as far as lifting power is concerned, they are 8% greater than we are. All we have is a crawler type of a vehicle; they have crawler and wheels both. Transmission speeds, we have three forward and one reverse; they have four forward and one reverse. They have an air-cooled engine, while we were struggling along here up until three months ago with a water thermasyphon system. Now we've got a pump on the job, but that pump is actually falling apart. As far as maneuverability is concerned, they can travel any place. They have prop, wheels, full track and half track; all we have is propeller and track. They have a completely universal job; they can hang equipment on it. We can't even get engineered tools to go with our job. As far as hitches are concerned, we've got a drawbar, they can fasten anything onto their job. As far as speed is concerned, you ought to ride all day in a Helitrac.

CHIEF ENGINEER

No wonder we don't sell Helitracs. He's selling the competition.

SALES MANAGER

I don't have to sell the competition. They're doing fine by themselves. Ned Patterson, out in Kansas City said to me the other day: "Carl you haven't changed a damn thing for two years. Couldn't you at least change the color of the Helitrac?"

VICE PRESIDENT

Now, Carl, you've sold a million of them. They can't be as bad as all that. What's the biggest problem you face? Maybe we can do something about it.

SALES MANAGER

Price. We have over 3000 dealers and I ran a survey decreasing the cost of the Helitrac in steps of $50. We found that if we at least modernized the vehicle we could sell more than the 150,000 we sold this year. And if

we could get the price down to $1200 we could sell 450,000.

VICE PRESIDENT

Do you think that's a practical price?

SALES MANAGER

Sure, we can do just like the automobile fellows do. They sell a $1500 automobile, but no one ever drives one out of the dealer at that price. We could sell auxiliary equipment. This would open up entirely new markets. We've got to have more than just a crawler type vehicle. I've talked with Ed and he feels it's possible to put wheels on it. We haven't even touched the earthmover field, and we could if we had allied equipment which could be attached to it. We could put out a roadside mower, a crop sprayer. We could bring out a farm runabout. There is a waiting farm market. We could really do a job there. And the export market, we can hit our foreign competition on their home grounds.

VICE PRESIDENT

How I love enthusiasm. Seems like the market is there if we can produce the right type of vehicle. Irving, what do you think? Is our manufacturing facility set up to supply this increased volume that Carl is talking about?

MANUFACTURING MANAGER

Arch, our manufacturing facilities are far from modern. We failed to keep pace with our competitors in keeping our equipment up-to-date and our manufacturing costs have gone up out of sight. Volume alone will not reduce our costs substantially as long as we continue to have high maintenance cost and low productivity due to outmoded machines and methods. This is especially true in our engine plant. The equipment has depreciated and deteriorated. Most of it was installed in 1939 and 1940. Although we have the capacity to build 250,000 engines a year now, we are only building 150,000. We should be building 1100 a day on two shifts; as a matter of fact, we're only working about a shift and a half. Now, I don't know whether you've been down in our shop recently, so I'd like to show you a picture of the type of equipment we have. Look at that antique. The worker operating this machine must do a lot of heavy work.

(He shows them a few pictures of the shop)

These cylinder blocks must be pushed around a roller conveyor and loaded into the machine and into the jig manually. This results in a lot of scrap, relocating and a lot of tool breakage. Also, it is heavy work for the operators, morale is low and quality suffers.

VICE PRESIDENT

Is this pretty much behind what other people are doing in the industry?

MANUFACTURING MANAGER

Yes. Our competition is using modern, up-to-date transfer equipment. Here's another part of our shop. It's pretty dark, but that's the way the shop looks. That shows valve guides being machined on multiple spindle chucking machines. This is the most modern machine in the plant. Most of our broaches, reamers, and multiple drills are much older. If our Sales Department can assure us of increased volume, some reductions in cost can be made on our present engine and our present equipment. But real economy can only come through extensive machine modernization or automation.

VICE PRESIDENT

Irving, everybody talks about automation. I'm not sure that we know too much about it here in management, or we'd have done something about it before. Can you automate a job in the shop, regardless of how long a run you've got?

MANUFACTURING MANAGER

No you can't. Each job has to be analyzed and automation can be applied economically only to high production jobs. It merely involves the use of more automatic machines and controls, as well as automatic handling between machines, also automatic loading and unloading.

VICE PRESIDENT

And this gives higher productivity, is that right?

MANUFACTURING MANAGER

Higher productivity, better quality, lower cost. But any substantial reductions in cost to warrant a selling price anywhere near the $1200 Carl wants is impossible without completely modernizing our machine facilities where most of our excessive costs occur. Parts of our foundry would have to be modernized too. There are machine tools that will not only reduce product cost, but material handling costs, too. Tool breakage can be reduced and product quality improved as well. Modern machines, though high in initial cost, will pay for themselves in about three years.

VICE PRESIDENT

That sounds good!

MANUFACTURING MANAGER

However, automation has its limitations. It is not a cure-all. In the first place, I would hesitate to recommend that we automate the machining of our present 116 hp engine unless the Sales Department can assure us that this engine will be adequate for our needs in the next several years.

SALES MANAGER

I think that our present engine is very much under-powered. There's no use spending another dime on that particular engine.

MANUFACTURING MANAGER

I completely agree with you, this engine is 15 to 16 years old. Our competition has improved its engines and have kept pace with modern manufacturing advances. We are caught in the squeeze with an old engine and outmoded manufacturing facilities. As volume drops because we are not competitive

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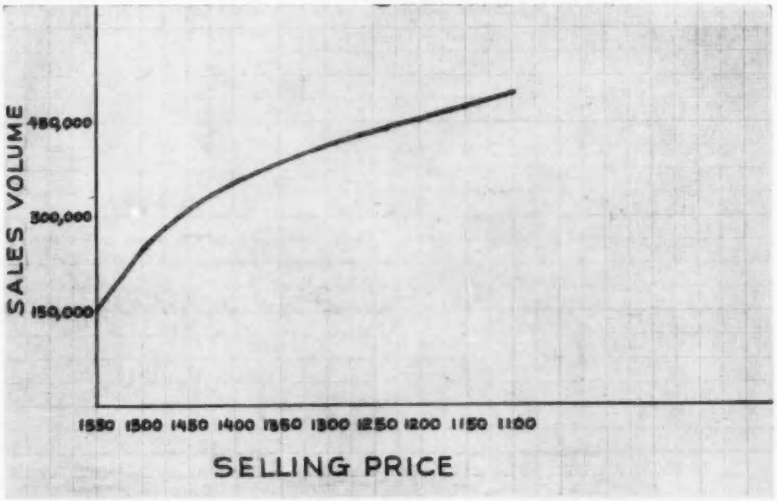
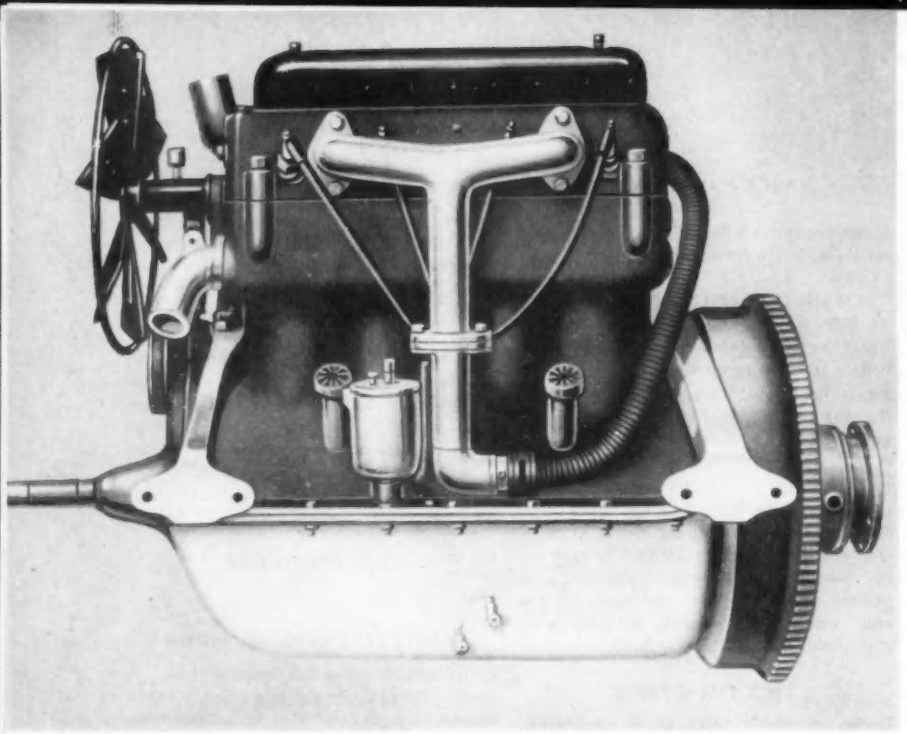
"If we modernized our vehicle and reduced the price, my survey shows volume would increase from 150,000 units @ $1550.00 to 450,000 units @ $1200.00 per vehicle."





"If it weren't for the flywheel I don't believe it would run at all! The old Helitrac engine was cast iron, 4-cylinder, long stroke, and had only two main bearings."

price-wise and power-wise, our costs increase. The extent of modernization of our plant will depend on the anticipated volume and the length of production run without extensive changes. If changes in the engine are contemplated, it is important to allow sufficient flexibility in the design. Furthermore, any new engine should be designed to permit maximum utilization of the latest production tools. Ideal manufacturing methods are greatly dependent upon engine design and we would like to work directly with Ed's engineers in the design of any new engine.

VICE PRESIDENT

Irving, I think that's a very excellent summation of the situation. Let me get this straight. If we did automate a portion of the plant, it's your feeling that our inventory would be lowered, our turnover would be greater, our final cost would be lower, and our working capital would be less. Is that right? We'd get all those things if we did that? (*The manufacturing manager nods his head*) And our sales volume should increase and more vehicles be built, and we'd need more people in the factory than we have now. Is that right?

MANUFACTURING MANAGER

Yes, Arch, there's just one other thing I should point out to you. Remember that any extensive improvements in our plant would require time. Machines have to be designed and built, and we cannot do this until we get releases from the Engineering Department.

CHIEF ENGINEER

How long would you need?

MANUFACTURING MANAGER

As things stand today, it would take us from 12 to 14 months to put this plant into production.

SALES MANAGER

Oh, we'll be buried by that time!

VICE PRESIDENT

Now Carl, you really enthused us here a little while ago, what happened?

SALES MANAGER

I'm still enthusiastic, Boss.

MANUFACTURING MANAGER

I still insist it will take us from 12 to 14 months to get into production. To accomplish it, we would have to build a bank of these engines to last for that period of time.

SALES MANAGER

We don't need much of a bank; we've got that now.

(*The characters laugh*)

VICE PRESIDENT

Carl, you think about doing something on the present vehicle as an interim step. Ed, you've heard this very sad story in the field on sales and manufacturing, what do you think?

CHIEF ENGINEER

Well, I certainly have sympathy for the Sales Department, but Carl is kind of like all salesmen, they can all sell something they haven't got. We have been conducting a great many tests on the Helitrac in relation to the competition. We've had them running at the proving grounds and we feel that there are many attractive features on the Helitrac that you haven't taken advantage of, Carl. I would just like to suggest that you consider going over those advantages with us. We think it might provide a sales stimulus for the interim business and help with the inventory problem.

SALES MANAGER

(*He leans forward and answers hotly*)
I wish I could just take one of your boys and have him sit down and draw up those advantages you have. I'll bet it would be a very small sheet.

VICE PRESIDENT

Now, now just a minute. We're just in the family here.

CHIEF ENGINEER

I can't help, Arch, but agree with Carl that the engine we currently have is under-powered. Remember that you repeatedly cut our budget in engineering; you wouldn't let us hire some of those new men who came along, and we were at a real disadvantage. However, we do have a design of an entirely newly powered Helitrac with the . . .

VICE PRESIDENT

(*Interrupting*)
You have?

CHIEF ENGINEER

We've been doing some design work on our own. This new Helitrac has equipment that Carl has been asking for. It will provide not only the sales stimulus but it will provide an obsolescence factor.

SALES MANAGER

That's good news to me.

CHIEF ENGINEER

We've gone ahead with many of our experimental designs. We have had a number of vehicles running with different types of engine equipment. The old engine, as you fellows know, has four cylinders. It's cast iron, it has a long stroke, only two main bearings; and when we go beyond about 4½ to 1 compression ratio, the crank deflects about 1/16 of an inch. If it wasn't for that flywheel on there, it wouldn't run at all.

SALES MANAGER

A guy would have to be a Houdini to sell that thing.

CHIEF ENGINEER

Well, you know we enjoyed some good prosperity immediately after the war and our management felt that rather than pour money

into modernization of the equipment and to provide new designs they'd try to stretch their luck. We had a thermal-syphon water pump system. We had to stick that on because you were trying to use some of these things out in the mountainous areas and we couldn't get any cooling. We've had an awful problem with that pump ever since. And this carburetor doesn't belong on this engine. We had to design it so narrow to meet some of your requirements, that we had to put on a real long pipe and consequently, we've had a lot of problems with carburization, especially on slope operations.

SALES MANAGER

I'll admit those were desperation moves, but they kept us in business three months longer.

CHIEF ENGINEER

The efficiency of our engine has been quite low because we haven't been able to increase the compression ratio due to the structural design and characteristics of the engine. I just want you to know this, Carl, so that you might have an alibi if some of your high-powered salesmen start to question why we didn't increase the compression ratio of our engine like the Vamp did.

SALES MANAGER

I can't sell alibis. Our customers don't want alibis; they want the product.

CHIEF ENGINEER

We realize that, and they don't pay dividends to the shareholders either. I thought it might be desirable for our management, who are not too close to some of our real problems, to see the actual situation.

VICE PRESIDENT

(He shifts in his chair uncomfortably)
I think I'm seeing some of it, Ed.

CHIEF ENGINEER

We have a choice of new engines. There is a V-8 engine we've designed but it's cast iron. It is designed to take full advantage of the automation equipment that's now available and I'm sure that Irving could automate this type of engine very satisfactorily. However, we feel that perhaps this engine doesn't give us the advantages we would like to have because the Helitrac needs a fairly lightweight engine. So we have been studying and have designed, and have all drawings ready for release, for both the V-8 type or a new horizontally-opposed six-cylinder engine. Now this engine is 302 cu in. as opposed to our present engine of 235 cu in.

SALES MANAGER

Does it have to be that big, Ed? Remember we have to sell this job for $1200.

CHIEF ENGINEER

You should be talking! You wanted more power, we're giving you something and now you're hollering about it. I really shouldn't be selling this job or showing it to the Sales Department because this is something we plan to bring along a little later. It uses fuel injection.

VICE PRESIDENT

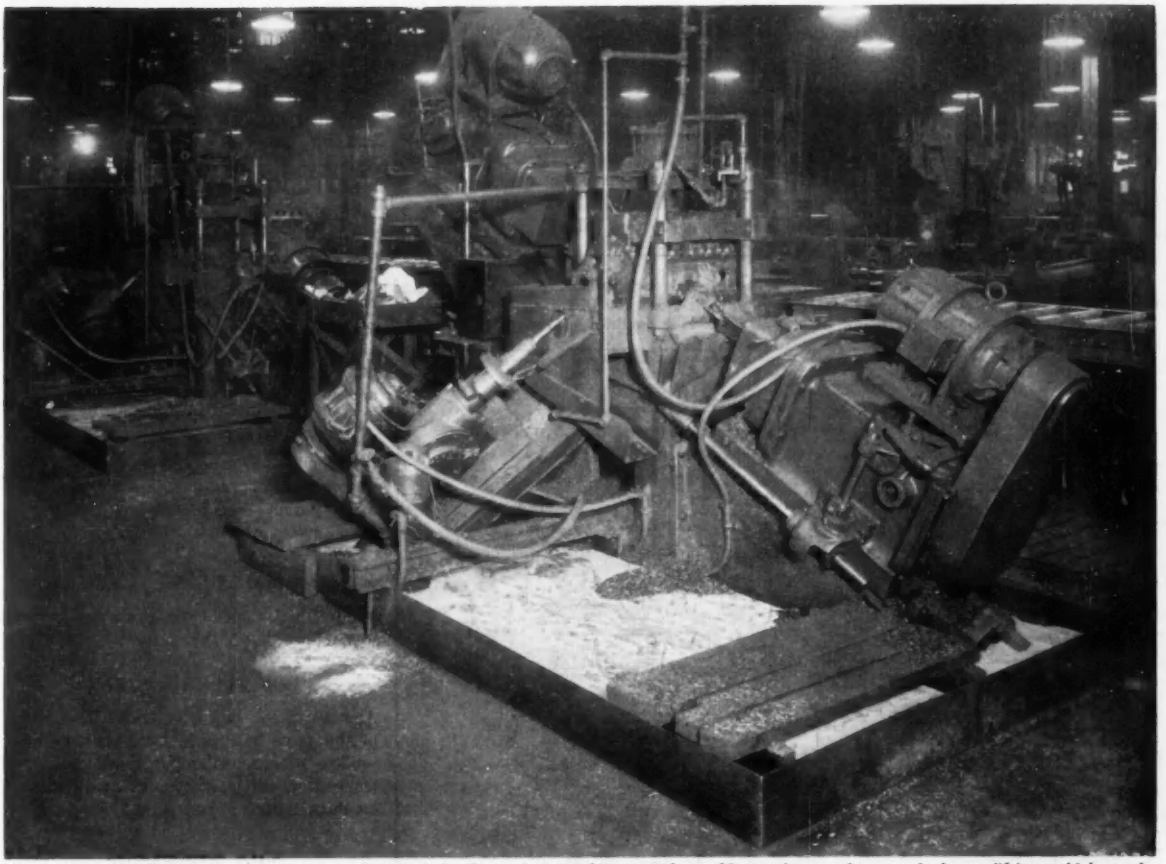
Well, shouldn't the Sales Department know about that?

SALES MANAGER

That's right, Arch, we need encouragement.

CHIEF ENGINEER

Like all Sales Departments, they've got to



"It's pretty dim but that's the way our plant looks! Outmoded machinery such as this requires workers to do heavy lifting, which results in slow production, low morale, tool breakage, and unnecessary scrap. New automated machinery is the only solution."

get two-toning or some kind of shot in the arm annually. We felt that perhaps the carbureted engine would be a better one to start with. It would give us a chance to become familiar with some of the characteristics of this new engine before we got into injection. However, the type of injection we have here has been used and we feel it is very satisfactory. This engine lends itself to supercharging, and since a lot of your business will be devoted to export type of business, altitude operations, and mine exploration and oil exploration work, we feel that you will want to make available a supercharged version of this engine. So, we think this is a start and we would like to have some time to work with the Manufacturing Department, and work with the Purchasing Department to see what we can do to develop it.

VICE PRESIDENT

Ed, I agree with that thoroughly. Carl, you certainly must have the idea that we've got an Engineering Department here that will come up with what you want.

SALES MANAGER

I do.

VICE PRESIDENT

That's fine! You folks should get together.

CHIEF ENGINEER

We've been together, but when we give it to them they don't want it and when we haven't got it they want it. I'd like to make one more point from an engineering angle. We feel to take full advantage of our modern engines, we must change our transmission. We need a new automatic transmission on the Helitrac.

VICE PRESIDENT

We certainly will consider it, Ed. When we see how all this adds up in the way of money, what can be arranged and how it can be raised, we'll certainly consider all of these points. The transmission is probably a must, is it not, from what I gather?

CHIEF ENGINEER

It's our recommendation. We think it will give us a tremendous competitive advantage.

VICE PRESIDENT

I've heard about the transmission on this foreign job. Well, I think you and Irving and Carl should get together on this design and work up a very definite recommendation of what should be done. Now, Frank, on the Purchasing end, I've been looking at some of the costs of these things you're buying. Sometimes I wonder whether you're selling or buying. They seem to be going up and up, and I don't see any of them that ever dropped. Have you anything to say about this situation?

PURCHASING AGENT

Ordinarily, purchasing agents don't have anything to say. Very often when they do say something, nobody pays any attention to them. But I've been waiting for this opportunity for a long time. I'd like to say just this. This company is run entirely too much to suit some individuals, not for the purpose of getting the best price.

SALES MANAGER

I believe you, Frank, I'm right on your side.

PURCHASING AGENT

Now you wonder why costs have gone up. Prices of labor and materials have gone up and our volume is dropping off, backing up. It's enough to drive prices up. But that's only the beginning. We are buying the damndest things in this corporation that you ever heard of. Now just take that pump we're buying. If Rube Goldberg didn't design that he should have. Nobody can possibly make it. We've got tolerances on prints that can't possibly be held. Manufacturing does not want to make it; they can't make it. So they say the obvious thing, "give it to Purchasing, let's buy it."

SALES MANAGER

And we have trouble selling it.

PURCHASING AGENT

No small wonder. Who wants it?

VICE PRESIDENT

Well then, Frank, why don't we make it?

PURCHASING AGENT

That is a good question! Why *don't* we make it, why don't we study what should be bought and what should be made? On the other hand, we are making things that obviously should be purchased. We have vendors that specialize in transmissions, carburetors,—people who make a business and spend thousands of dollars each month doing research on those things. What do we do? We make them! Are they as good as our competition uses? Of course not, they can't possibly be. Thats why costs are going up and why we are not competitive. Our manufacturing shop wants to make the easy things, and we've got all our floor space filled up with screw machines. In the first place they're buying a lot of screw machine items that should be made on a cold header. I can cut the price in half if you'll give me a little tolerance and let me buy cold header parts instead of screw machine parts.

MANUFACTURING MANAGER

I didn't pick those parts; I was told what I was supposed to make.

PURCHASING AGENT

Another thing. We have no business being in the valve business. Even now we have vendors who are willing to invest their own money if we will guarantee them some volume on these types of specialized products.

VICE PRESIDENT

What should we be buying, Frank?

"We plan to expand our dealer organization to handle the increased sales volume expected from Helitrac's new markets. Versatility of the new vehicle will increase sales in farm, earth-mover and highway maintenance fields, as well as give us a foothold in the export market."

"We've got to raise between $100,000,000 and $120,000,000 for this new program. Manufacturing needs $55,000,000 for automation." Left to right: Hecker, Woolson, Colwell, Cole, Farrell.

PURCHASING AGENT

Carburetors, valves, tappets, not to mention the transmission.

VICE PRESIDENT

All right. If you feel so strongly about the fact that you haven't been listened to, don't you think that you and Ed and Irving should get together on a committee to determine what we should make and what we should buy? Will you head that up as chairman?

PURCHASING AGENT

You bet I will; I'd be glad to.

SALES MANAGER

I'd like to see us buy more because I think in that way we'd have more flexibility. We wouldn't have to live with a design for five years.

VICE PRESIDENT

We're going to have another meeting in six weeks and I'd like everybody to come in with definite recommendations as to what is to be done. Irving, I think you and Ed should look at the best way of making the high volume parts, depending on the design Ed picks for this engine. And Frank, you should look into the vendor field; the parts we're going to buy; what can be bought better; what we can do in the way of delivery; what they're willing to do to put in equipment themselves. You chairman this "make or buy" committee and come in with some recommendations next time as to what is to be made and what is to be bought. If we are going into this new automation equipment, Irving, I want some idea of the cost of it because we've got to raise some money. We've got to rearrange the factory and Ed probably needs some money on this redesign. Also, Ed, I think we should pay some attention to what Carl says and come in with an interim recommendation as to what can be done to our present model to help him in the meantime until we can get this program moving. We've got to clear out this $65,000,000 inventory which is a good part of our working capital. If everybody is in agreement then this meeting is adjourned. I will be in touch with you for another meeting in about six weeks.

(*Lights Dim*)

ACT TWO

TIME: *Six weeks later*

SCENE: *Same as Act One*

(*As the lights go up, we see the same executives already seated at the conference table. The executive vice president glances over papers in front of him, and clears his throat. The others stop chatting and turn to him.*)

VICE PRESIDENT

Well, we've had six weeks to think this over and I know everybody has been working on the job. I talked to the treasurer. We can raise $100,000,000 if necessary. And today, I hope we can find out what this whole program is going to cost. I think the first thing we should know, Carl, is your check on the field survey, and if you still feel this is practical and not just a dream.

SALES MANAGER

Every check that I've run, Arch, has shown that our sales forecasts are way below our possibility. We know that we can sell 450,000 Helitracs a year, all we have to do is keep that price down to the $1200 figure that we're talking about and get these various modifications in the vehicle. The 450,000 Helitracs will give us sales of $540,000,000; and we'll have $48,600,000 after taxes. To help the situation I know a customer who would buy close to 400,000 of the new type engines from us. He's not in competition with us and that would increase our sales volume.

VICE PRESIDENT

How would it fit in with the main program?

SALES MANAGER

I've worked out the figures and I think we'd get about $1,500,000 net after taxes.

VICE PRESIDENT

That's not much considering the capital investment.

SALES MANAGER

True, but the advertising would be splendid for us, and it would help us diversify the company.

VICE PRESIDENT

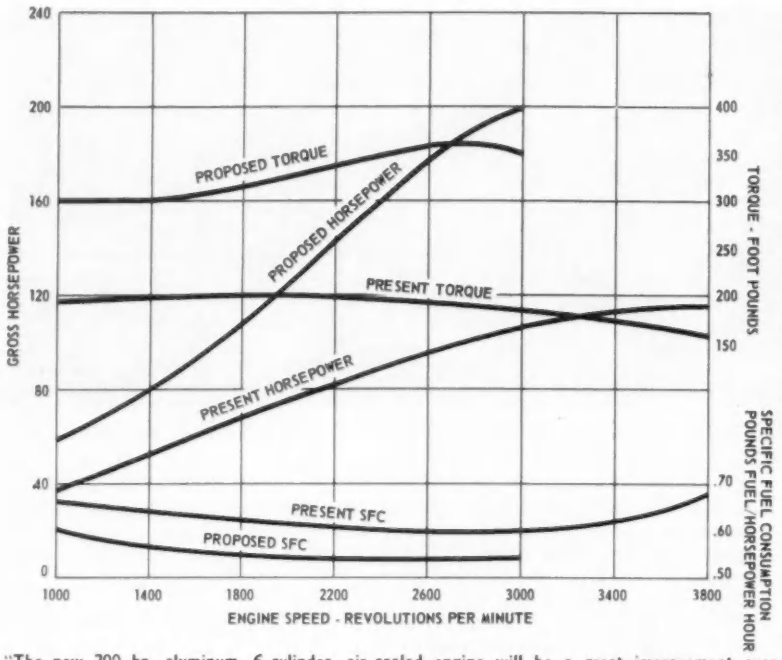
Carl, that's interesting. Added to our $48,600,000, that would give us a net of over $50,000,000. A little better than seven dollars a share. That's pretty small income, I believe for the amount of money we have put into it, but we'll investigate that. However, $48,600,000 looks like a very interesting and optimistic figure. If we could get that, why we'd be back in business.

SALES MANAGER

We're really enthusiastic about this job. We've got our dealers hopped up. Wherever a propeller spins, wherever a tractor track crawls, wherever a wheel turns, it's a Helitrac in 1957! And we'll make it that way!

VICE PRESIDENT

Good! Ed, what do you come up with in engine design that you think we ought to go ahead with?



"The new 200 hp, aluminum, 6-cylinder, air-cooled engine will be a great improvement over our old one."

CHIEF ENGINEER

We spent considerable time working with the Manufacturing Department's master mechanic to make the necessary modifications to fit the most efficient automation equipment on both the wheel type design and the 6-cylinder opposed aircooled engine. We have both the designs, ready for release. However, after discussing this thing with the Sales Department and due to the request Carl has made for the sale of engines to a non-competitive manufacturer, we are recommending that we adopt the aircooled type of engine. There's about a 30% improvement in specific fuel. Our present horsepower only gets up to about 118 at 3800 rpm and the torque curve is pulling 200 lb; whereas, in the proposed engine we have limited the speed to 3000 rpm for a definite reason. Carl has requested a new rating for the tractor and by cutting the speed, we have been able to eliminate some extra gearing which would be required as a reducer.

SALES MANAGER

Do we have to go that large with the horsepower, Ed? That's a beautiful torque curve, but do we have to have that much power in this job? That's a terrific advance from our present design.

CHIEF ENGINEER

Well, the way we look at it, the rest of the design is capable of withstanding this torque and horsepower and we feel that horsepower and performance is feasible providing you can get the efficiency. We have the efficiency, and I would recommend strongly that we continue with this program, with 302 cu in. and about 350 ft-lb torque and the 200 hp.

VICE PRESIDENT

Carl, I think Ed's looking several years ahead on this design and I go along with him on this.

CHIEF ENGINEER

I also feel that this engine is capable of further exploitation such as high compression and fuel injection, as well as supercharging. That's why we're so interested in going to the aluminum construction. You see here, this chart shows the proposed engine and horsepower per cubic inch. And you can see that the specific improvement is about 25 or 30% better than our present engine. But the big factor is the horsepower per pound. For the type of vehicle we're planning, the weight reduction is a tremendous advantage. So we feel, because of these various characteristics, from the sales point of view that the 6-cylinder opposed engine is the right one to use. Further, we think from an automation point of view, from tools and equipment and investment, that we certainly should consider as much aluminum as we possibly can. I spent considerable time with the aluminum suppliers along with Frank and they tell us that there is no shortage of base material. We've worked with the potential suppliers, talked to the machine tool builders in that area along with the master mechanic and they assure us that the machines to supply these castings can be made available to us.

VICE PRESIDENT

What parts do you plan to die cast?

CHIEF ENGINEER

The upper crankcase can be made out of a die casting and we plan to core many of the tapped holes directly into the casting so that we can eliminate tap drilling. We've also done many other things from a die cast point of view so that we eliminate finishes and that not only eliminates operations but also eliminates equipment. To clean up this cylinder surface it can be easily milled and it lends itself to a high degree of automation. The engine is capable of increased compression ratio. The crank, the pistons, and the essential parts of the engine are designed to take the extra forces that will be imposed on them with higher output, and give a satisfactory durability and life. Now, if we can couple this engine with a suitable transmission I think our Helitrac will have considerable advantage over the Vamp.

VICE PRESIDENT

Do you think this will put us pretty well ahead of them for some time to come, Ed?

CHIEF ENGINEER

I think it will provide the stimulus that the Sales Department has been asking for.

VICE PRESIDENT

Carl, the air-cooled factor in some of these regions, particularly in the northern region should be of considerable help to you.

SALES MANAGER

It will definitely be a very great advantage.

CHIEF ENGINEER

You know we planned this vehicle to be used widely by the small farmer and the suburban dweller who has a snow plowing job or some periodic work. He doesn't have to worry about the coolant or freezing up. Frank, we'll eliminate that pump you were talking about.

PURCHASING AGENT

That's great!

VICE PRESIDENT

It makes me feel good to see the gang pulling together to do this job. Ed has designed this so it can be automated, Irving. Now, what new equipment will you need?

MANUFACTURING MANAGER

We've worked very closely with Ed Cole and we've had complete cooperation of the Engineering Department; also complete cooperation of Frank and the Purchasing Department. And we're very happy with the design of the air-cooled engine from the manufacturing standpoint. The extensive use of aluminum alloys in this design permits us to both cast and machine many of the engine

parts at a very high rate. Furthermore, the design of the new engine will enable us to automate the machining of cylinder heads, crankcase, crankshaft and manifold. Those are the parts that we feel adapt themselves to automation because of the quantity and the amount of machining.

The engine's characteristics make us so confident of its long-range potential and flexibility that we have no hesitancy in recommending the purchase of a single-purpose, highly-automated equipment. We know the machines will not be obsolete for some time to come. And as Ed has explained, these other changes and improvements contemplated for the future could give us more power and more torque if we need it.

CHIEF ENGINEER

I'd just like to mention here to Arch that we spent a great deal of our time studying the flexibility of this automation equipment and what would have to be altered in case we would want to make interim model changes if Carl found he was in a poor competitive position. I think we are providing the flexibility in this equipment to justify the investment.

VICE PRESIDENT

Well, that's wonderful.

MANUFACTURING MANAGER

We're basing our recommendations on the flexibility that Ed has designed into this engine and I know that Carl from the sales angle agrees with it.

SALES MANAGER

And I'll be able to get yearly changes in model design?

CHIEF ENGINEER

You'll get more than yearly changes.

MANUFACTURING MANAGER

The scope of this modernization program is tremendous in a company of our size. But, I think the equipment will pay for itself in three years.

VICE PRESIDENT

Three years, Irving! That's awfully good.

MANUFACTURING MANAGER

Just in manufacturing cost reduction. We can install the most modern equipment in our engine plant and increase our engine capacity from 250,000 to 450,000 engines a year without any additional floor space. Furthermore, automation permits us to build these additional units at about the same total engine cost.

VICE PRESIDENT

The engine cost? What about the complete unit if we buy some of these things outside?

MANUFACTURING MANAGER

We are in accord with Frank on the purchasing policy. Our committee has worked closely with him.

VICE PRESIDENT

How much will automating our shops cost?

MANUFACTURING MANAGER

The cost of automating the engine plant to produce the 450,000 engines will be $45,000,000. And on top of that, we estimate $10,000,000 for foundry facilities to convert from cast iron to aluminum die casting. This will require an organized program to familiarize our workers with a new type of machine. It will require close coordination with our Purchasing Department and the machine tool suppliers. It will mean an immediate engine banking program.

SALES MANAGER

I don't know where we'll put them. We're overloaded now.

MANUFACTURING MANAGER

Engines will be stored any place that we can find available. We may have to rent space. This will of necessity increase our inventory. As soon as sufficient engines are built and stored, the old machinery will be dismantled and removed from the plant. Now we figure that our plant is big enough to take care of this and we will not have any major structural changes to make in the plant facilities. However we feel that we should tear out the whole floor of the building because with this new heavy transfer equipment we'll require very deep and rigid foundations, besides which we have to take care of chip disposal systems in the floor. Just to give you an idea

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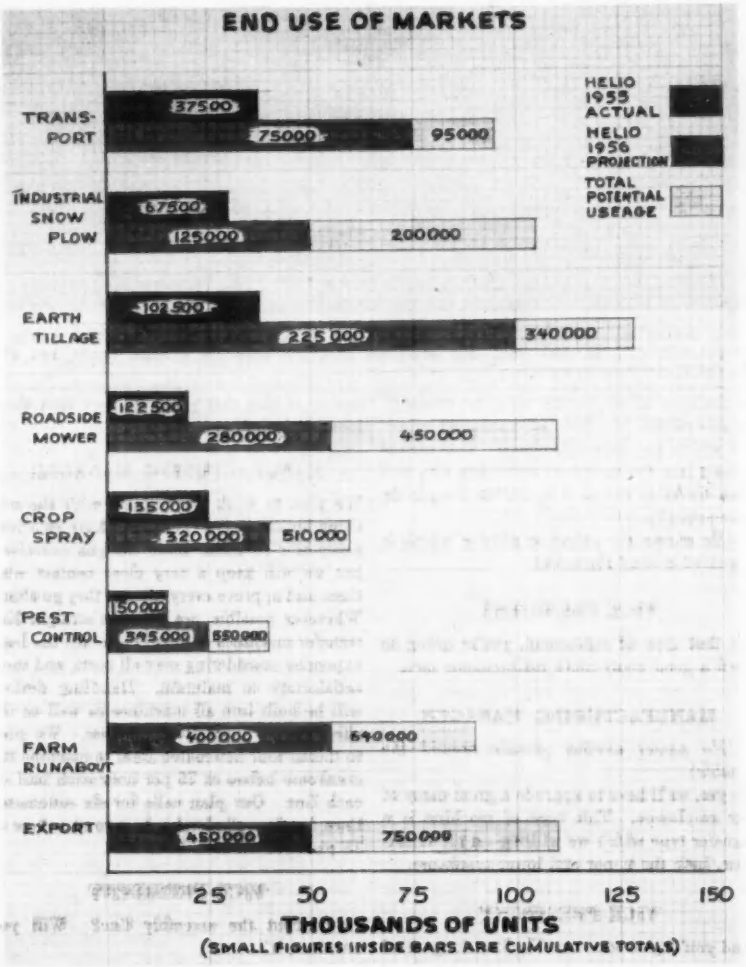
"A higher-powered engine and auxiliary equipment on the new Helitrac will enable us to expand our earthmoving, highway equipment, and farm markets. Also we can begin exporting and meet our competition on their home grounds."



"Four automated lines will be installed to machine the upper and lower crankcase halves at 75 per hour each on each line. Six automated lines will work the cylinder heads, two at a time at 75 per hour on each line."

of the type of equipment we'll be needing: In this picture is a body of crankshaft grinders which are fully automated. The cranks are set into the machines and taken out, and then travel to the next operation completely automatically.

(He shows the others a picture which is passed around the table)

VICE PRESIDENT

On that type of equipment, you're going to need a good many more maintenance men.

MANUFACTURING MANAGER

(He passes another picture around the table)

Oh yes, we'll have to upgrade a great many of our employees. This type of machine is a transfer type which we will use on the crankcase, both the upper and lower crankcase.

VICE PRESIDENT

And you'll give some outside firm the general design of this that you want and turn them loose on it, is that it, Irving?

MANUFACTURING MANAGER

We plan to work very closely with the machine builders. We would not have sufficient manpower to make these designs ourselves, but we will keep a very close contact with them and approve everything as they go along. Wherever possible, we will use straight line transfer machines because these are the least expensive considering over-all costs, and most satisfactory to maintain. Handling devices will be built into all machines as well as the checking for inspection purposes. We plan to install four automated lines to machine the crankcase halves at 75 per hour each half on each line. Our plan calls for six automated lines for the cylinder heads, two at a time at 75 per hour on each line.

VICE PRESIDENT

How about the assembly line? Will you automate it?

MANUFACTURING MANAGER

We intend to go into automation on the assembly as much as possible. Most of the attaching bolts will be done with bodies of automatic wrenches, and that will improve quality because we get uniform torque. We believe that we can do the same thing with main bearing bolts and connecting rod bolts and similar parts. Not only will this automation reduce manufacturing cost, but it will give us a better quality, reduce scrap, reduce tool breakage, increase safety, and increase morale among our employees. It will permit our workers to assume more interesting, higher skilled jobs with a lot less effort. This program, together with the increased volume, permits us to build Helitracs with a more powerful engine, equipped with an automatic transmission to sell for $300 less, at a much larger margin of profit.

However, even though Carl says he can sell 400,000 additional engines, we do not recommend it at this time. It would require additional buildings, additional investment in machinery and for the amount of profit after taxes that can be made we don't believe it would be wise to make this investment at the present time.

VICE PRESIDENT

Irving, on the first $55,000,000 you talked about, have you some idea of the return on investment of that money?

MANUFACTURING MANAGER

Yes, of this $55,000,000, the profit will run about 9% on sales after taxes and 24% return on investment, which I believe everyone here will agree is a pretty good rate of return.

VICE PRESIDENT

If we can accomplish what you've laid out here with Ed for that investment, I'd say that's rather phenomenal. Frank, how is your "make or buy" committee coming along?

PURCHASING AGENT

We've decided that a number of items should definitely be purchased which were heretofore manufactured. Items that were manufactured should continue to be manufactured and others that were purchased now should be manufactured.

VICE PRESIDENT

You're pretty much in agreement on them?

PURCHASING AGENT

Yes. One of the items we've gone into at great length is the automatic transmission and we have worked very closely with Mr. Robinson of the XYZ Transmission Corporation, and I'm sure that his Jerky transmission is familiar to us all. Mr. Robinson is in the

lobby and I'd like to have him brought in here and talk to you.

VICE PRESIDENT

For heaven's sake, let's get him in. I'd like to hear what he has to say.

(Frank goes to the door and ushers in the vendor, who is warmly greeted. The vendor sits at the end of the table)

PURCHASING AGENT

Now, Robby, as usual the vendor is under a handicap. No one knows better than you that if a vendor doesn't speak up he's a dead duck.

VENDOR

That's a handicap I've been working under for years, Frank. Gentlemen, I'm very happy for the opportunity of meeting with you all. This transmission matter is something on which we've been working very closely with Frank and Ed for over a year. We appreciate that it's a very major part of your program and your decision as to whether to purchase this outside or make it yourself is obviously a very important policy matter. We are quite familiar, through our work with Ed, with your new Helitrac design. We have a great deal of confidence in it. We think you've got some real ideas. As far as the transmission is concerned, I believe you know the many years of experience we've had in designing and manufacturing them. We have been able to take one of our existing designs of automatic transmissions, adapt it to your particular application, at the same time incorporate a number of ideas that Ed Cole has had to suit your particular problem. We have built prototypes which have been thoroughly tested, I believe, to Ed's satisfaction.

CHIEF ENGINEER

I'd like to say one thing, Robby, so that our management is aware of the great contribution your organization has made in the development of this transmission. I would like to have Frank take that under consideration too in his dealings with you. You aren't coming in completely cold, you've been working with us for over eighteen months on this thing and we feel you've made a tremendous contribution.

VENDOR

Thanks very much, Ed.

PURCHASING AGENT

I've been trying to tell that to our management for years. No one listens to me. There isn't any question about the contribution that our vendors have made to our business and can make.

VICE PRESIDENT

Frank, we're going to listen to you from here on in, I promise you.

VENDOR

Gentlemen, we feel we could make still more contributions. I'd like to tell you just a few of the features of this transmission.

(He shows them some photographs.)

We call this the "power package." It's a unit rated from 200 to 250 horsepower which allows for some reserve for increasing powers. We can supply it either with or without a brake. Essentially the unit is a 6-speed, hydraulically-actuated transmission, combined with a converter-hydraulic torque converter—a very efficient one, in which is also incorporated a lockout, so that when the engine reaches a certain speed, the converter can be locked out and the maximum efficiency obtained in each ratio.

CHIEF ENGINEER

That's a very important feature in this design.

VENDOR

The transmission shifts automatically from one speed to the other and the shifting is shock-free. Very smooth shifting. There are three ranges in the transmission which are engaged by a range lever. There is one range of four speeds which is used for most highway service, most normal driving, and all of the high speed range. There's another two-speed range which is adaptable to the hilly country where the terrain is uneven and more reductions are required. And a special low speed range which is especially suited for such heavy work as snow removal, or plowing, or this operation of digging out of the red.

VICE PRESIDENT

This operation of what, Robby?

VENDOR

Of digging out of the red. It seems to be quite a job nowadays. There are two power take-off openings. One of them, which is driven through the converter, is ideally suited for driving auxiliary equipment and the other is easily adapted for driving a helicopter attachment.

VICE PRESIDENT

I'm sure that Ed is familiar with all those technical details. What I'm particularly interested in is what can you offer us in the way of building this transmission that would be better than doing it ourselves?

VENDOR

Well, Mr. Colwell, you must have this new vehicle of yours priced competitively. You must have a reliable source for all of your components and you must have prices that are as low as they can be made. In making your own transmission, which you've been doing for years, your tooling has grown old. You haven't been able to make a more modern transmission because of the high cost of retooling. To make this transmission yourself you would have to go into a great deal of additional and new capital equipment, new machinery; you would have to completely re-tool all the parts because it's a completely new design. We on the other hand have a large transmission plant; we have modern equipment. Many of the components of this unit are already in production for other similar units; they're already tooled. Some of them are actually being made under automation methods. Today, the addition of this volume of yours will make it possible to automate a number of other parts, so that we can make all these parts at a maximum efficiency.

SALES MANAGER

Robby, we get a lot of changes from our customers. Every six months someone comes in with a new job and new range of speed. Are we going to be able to get those changes in speeds in that transmission as easily as we could if they were in our own plant?

VENDOR

In making transmissions for a number of customers, we have been up against a constant demand for changes and modifications, and all of our manufacturing has to be set up with that in mind. We can make those changes cheaper, easier and quicker than you can.

PURCHASING AGENT

Carl, I'd like to add a few words. We've gone over that quite extensively and we've talked to Robby's other customers. We know what they have done in the past and I know positively that they can make changes that we may want much easier than we could if we had the equipment in our plant. They have much greater flexibility.

SALES MANAGER

We have a hard time getting service parts in a lot of cases on some of these purchased items. Are we going to be able to get them on this transmission?

VENDOR

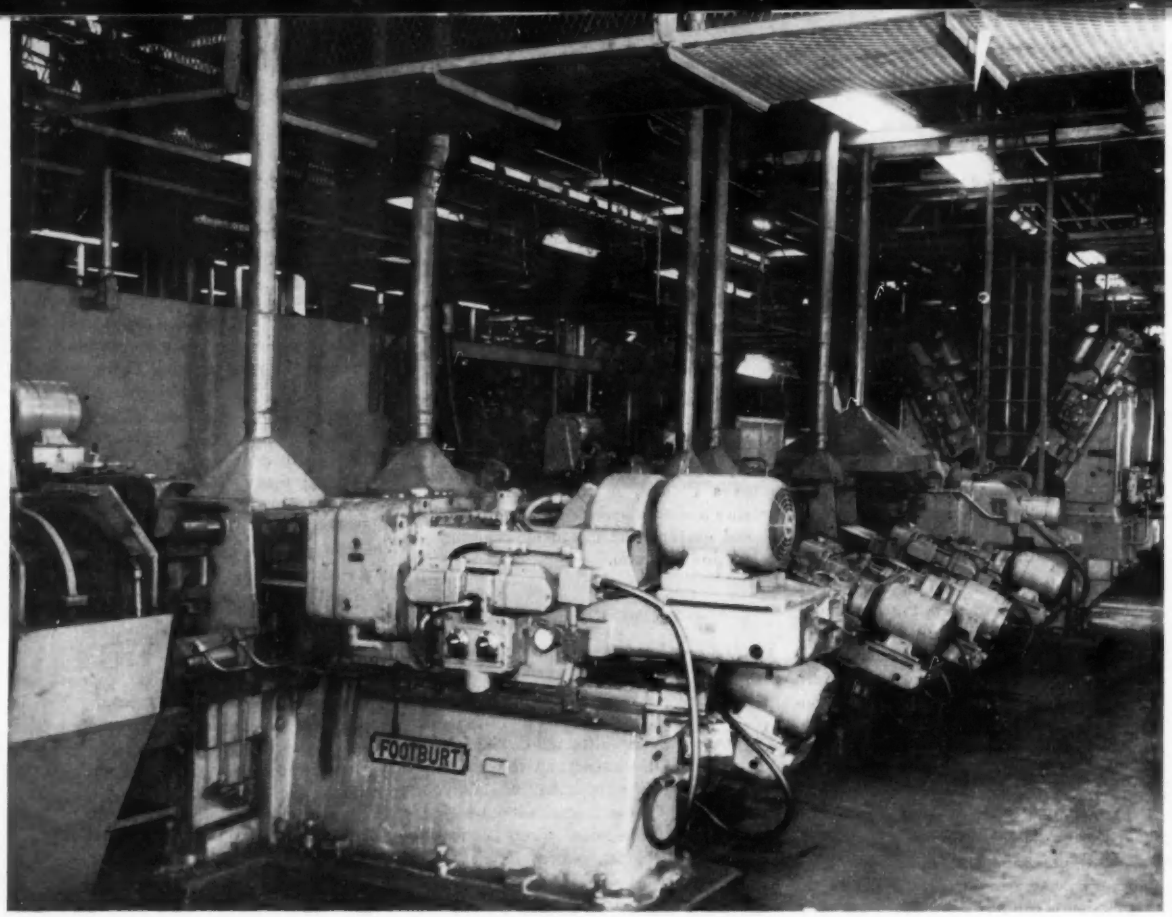
I will personally guarantee that you'll get them.

VICE PRESIDENT

Does that settle it for you, Carl?

CHIEF ENGINEER

I think, Carl, that this transmission will perform beyond anything that you've expected and very soon we're going to arrange for a demonstration of this complete unit for you and your sales staff.



"Automated machinery similar to this will be used in the Helitrac plant to make the new engine. Wherever possible straight line transfer machines will be used."

VICE PRESIDENT

Frank, when you're talking about these parts from outside, are you that confident you can get them in on time and not hold us up on the building of these vehicles?

PURCHASING AGENT

You're talking now about the purchased parts or the capital equipment?

VICE PRESIDENT

The purchased parts.

PURCHASING AGENT

We always scream and holler for the purchased parts, we get them in by having our vendors work overtime, and most of the time they sit there until our own matching parts can be manufactured.

MANUFACTURING MANAGER

I take exception to that.

PURCHASING AGENT

It's true, it's a matter of history. . . .

VICE PRESIDENT

(He senses an argument starting and squelches it)

Just a minute. I think we may excuse Mr. Robinson at this time. Thank you very much, Robby. We'll be in touch.

(The vendor gets up, gathers his papers together, puts them in his briefcase.)

VENDOR

Thank you. I appreciate your confidence in calling me in to help.

(The vendor shakes hands with those nearest him and is taken to the door by the Purchasing Agent. They whisper for a moment and the Vendor leaves. The Purchasing Agent returns to his place.)

VICE PRESIDENT

Now then. Did you have something to say, Irving?

MANUFACTURING MANAGER

I don't agree with Frank about manufacturing delays, however I will say this. We'd better get our transmission from a good reliable source. We can't afford additional manufacturing facilities or the capital investment to do it ourselves.

VICE PRESIDENT

Then it looks like we all agree. You in agreement, too, Ed?

CHIEF ENGINEER

Yes, I think that's the right decision. It will open up some space for Irving in the shop.

MANUFACTURING MANAGER

It certainly will help out.

VICE PRESIDENT

It looks to me, if we're in agreement that we should go on with a program something like this. The 450,000 Helitracs with a return on investment of 24% is not bad. But when we add the additional engines to it, that return on investment is not so good, and it's going to take additional money to build. I would think that we should go ahead with the 400,000 to 450,000 units but look at these additional engines at a later date. How does that sound to everyone?

CHIEF ENGINEER

I think that's a good decision.

(The others nod agreement)

VICE PRESIDENT

Now, you say you'll need $55,000,000, Irving?

MANUFACTURING MANAGER

Yes, we'll need $55,000,000 to do the job we're talking about.

VICE PRESIDENT

All right. We have a working capital at the moment of about $75,000,000. We'll need an additional . . . if you do $480,000,000 a year, that is about $40,000,000 a month and we want $3.00 per month of the working capital, that's $120,000,000. So added to your $55,000,000 here, $175,000,000. We have got to raise somewhere between $100,000,000 and $120,000,000. I've talked to our treasurer and that can be done. We probably can put out common stock with rights three to four points below the market. The stock has been selling about seven times earnings, based on the year before last which is about $40. We could raise half of that by issuing rights and that would be perhaps a billion and a half shares, something on that order. This would be a convertible preferred, probably converting at 2 to 1. I'll work that out with the treasurer but you can depend on the money to go ahead on this program. But in the meantime, what are we going to do about Carl and this inventory, Ed?

CHIEF ENGINEER

Well, Carl has been hollering about some of of the things we haven't got. We have shown him some of the features that we think are outstanding which are not incorporated in our competitive vehicle. However, we can go a step further. We feel that we can improve the engine we now have by incorporating a commercial carburetor that Frank has talked about. It will take out some of the tricks that are in our carburetor and improve the breathing characteristics of the engine. We also feel that even with those two main bearings in there, we possibly can jack up the compression ratio from 4½ to 5 and that will help a little bit. With the change in method of rating horsepower we can give you just about 15 horsepower to talk about.

SALES MANAGER

In other words, we're going to get some more of this same two-year stuff that we're getting.

CHIEF ENGINEER

Well we don't know what else to do in the meantime, Carl, and we feel that will give you quite a boost and in addition to that, Mr. Robinson proposed to me two or three months ago that he had an automatic transmission that could be adapted to this job that would get away from this problem which we are experiencing, especially in the mountainous areas, of being unable to ship this clash box. You get on a little grade and the clutch plate slides down against the pressure plate and you cannot shift the transmission. A lot of people have complained about this. We feel that by the incorporation of this semi-automatic transmission and by the addition of another power take-off that is requested by one of the suppliers of auxiliary equipment, that we can help you and give you something to talk about, and we'll give you that two-tone paint job you've been hollering about.

SALES MANAGER

I think we want to take a good look at that situation, Boss, because we have got service problems running out of our ears right now.

VICE PRESIDENT

You mean this two-tone paint job?

SALES MANAGER

No, I'll take the two-tone paint job, but I'm talking about this change in the transmission, this intermediate change, etc. We'd have to build up a complete service manual, and we'd have to build up a complete set of service parts in the field. I don't see why we can't get these guys to get this automation setup in so we won't have to take one of these intermediate jobs.

MANUFACTURING MANAGER

Arch, I'd like to point out once again, it will take 12 to 14 months to get production underway. And that is based on getting released blueprints from Ed Cole immediately. We can't do it in less.

VICE PRESIDENT

Carl, you can't automate a factory overnight. These machines have got to be designed; they've got to be built; they've got to be brought in; the people must be trained. I would say it's probably going to take more than 12 months.

SALES MANAGER

Can't we double shift.

MANUFACTURING MANAGER

Right now we're doing double shifts and everything else.

CHIEF ENGINEER

Carl, one of my boys came to me the other day and he said, "My wife has accused me of working 28 hours a day and 9 days a week." We don't think it's possible to do all the testing, short of 12 to 14 months. We've been through this problem with the master mechanic and the machine tool builders from the standpoint of design and we feel that's a good estimate.

SALES MANAGER

Well, we're so grateful for the changes that you're going to make in this new vehicle that we'll do anything you say.

"We specialize in making transmissions, and can supply our power package to you cheaper and faster than you could make it yourself," vendor D. D. Robertson (back to camera) tells Helitrac Corp. executives. Left to right: Sales Manager C. L. Hecker, Manufacturing Manager L. I. Woolson, Executive Vice President A. T. Colwell, Chief Engineer E. N. Cole, Director of Purchasing F. E. Farrell.

VICE PRESIDENT

Now, that's what I like to hear. You think you can get out and sell this one with no alibis?

(The sales manager smiles and nods agreement. The vice-president surveys the table.)

Are we all in agreement then on this program? Frank, are you in agreement? What are you going to do about expediting this equipment?

PURCHASING AGENT

Well now that is really a problem. As you know, we don't have a very good reputation with machine tool builders. Number one reason is we haven't bought any in twenty years. *(The group explodes into laughter and the tension is broken)* So the Purchasing Department will have to turn their caps around and do selling jobs. Get acquainted with these machine tool builders and live with them. Otherwise we won't get the delivery we want.

VICE PRESIDENT

Are you prepared to do that?

PURCHASING AGENT

We are prepared to do that and have already laid the groundwork.

VICE PRESIDENT

O.K. That sounds good. I guess we haven't bought as much over the last few years as we should, Frank. This has been quite an indictment of management, there's no question about that. The little money we stashed away doesn't look so good at this minute. Well, Ed, you're in complete agreement with the program we've outlined here? And Irving and Carl, you accept it?

CHIEF ENGINEER

Yes. We're ready to go.

SALES MANAGER

Yes, we want a vehicle for $1200 though.

VICE PRESIDENT

Well, we're going to do everything we can to give you this vehicle for $1200. In about thirty days when we get this program moving, we'll have a meeting and talk about what should be done with the rest of the vehicle, like giving Carl a little different paint and other requests Carl made. I think this has been a very successful meeting and it is very sobering to me. Management has been very much on the spot here. It should have been, because we've been completely asleep on this job. I think this is going to work out, we're back in business. Meeting adjourned.

(The lights dim as the men break up the meeting.)

THE END

BEHIND THE SCENES participants in the automation drama session were SAE vice-president for Production Activity E. H. Kelley, and D. S. Harder, session chairman. Harder, who is executive vice-president, Basic Manufacturing Divisions, Ford Motor Company, addressed the technical session luncheon before the skit began. He said:

"Never before has there been an industrial concept which imposes a greater responsibility on the design engineer and the manufacturing man. We, the members of the Society of Automotive Engineers, the men responsible for designing and fabricating automotive and aircraft equipment, hold in our hands an industrial approach, a philosophy, that can make this a golden era that will raise the standard of living of Mr. Average American.

But automation is not a universal prescription. And the dose that's right for one company may be lethal for another. You, the design engineers and production engineers, are the doctors that have to diagnose the condition of each individual patient and prescribe accordingly.

The stakes in today's competitive market are high, and the risk is high. We all must have a common continuing objective: the manufacture of a better product, with improved performance, capable of being produced faster and cheaper.

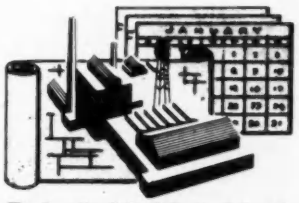
Automation offers a way of achieving this goal . . . but not without careful planning and coordination of engineering, production, sales and management.

The problems that beset an industrial firm that approaches the automation route will be brought out today by a group of men who are facing and living with these problems. Although the Helitrac Corp. is a mythical one and its product hypothetical, the problems that its executives face are very real."

C. R. Kramer
Development Engineer, Republic Aviation Corp.

and Adolph Kastelowitz
Chief Manufacturing Engineer, Republic Aviation Corp.

Based on paper "Forgings and Modern Fighter Airplane Producibility" presented at SAE Annual Meeting, Detroit, Jan. 12, 1956.



PLANNING *for* TOMORROW

Republic Aviation Plans More and Larger Forgings

REPUBLIC Aviation is planning to produce more and larger parts as forgings. The reasons:

- Forgings save weight in the finished airplane.
- Forgings cut costs. Final cost of a piece machined from a forging will be from 20 to 25% cheaper than an equivalent part assembled from many pieces.

What's more, as new techniques and bigger presses become available, the advantage of forging will increase. Less machining will be required. Larger parts can be forged.

Fig. 1 shows the favorable trend now evidenced by the percentage of material remaining in the part after machining. Note that at the end of World War II, when we used smaller forgings compatible with the size of presses available then, we retained 70% of the forging after machining. Then in 1950 we went to large, complicated forgings, and the state of the forging art forced us to machine away as much as 50% of the forging. Now with new methods and bigger presses with better controls at our disposal, the trend is toward less and less machining.

At present, Republic averages 57% of the forging remaining after machining. We hope that we will return to the former figure of 70% in the not-too-distant future.

Fig. 2 shows how the poundage of forgings has been increasing with each new design. Current designs use close to 6000 lb of forgings per plane.

The pictures on the following pages show forgings made by Wyman-Gordon for several Republic fighters.

For complete paper (in multilith form) on which this abridgment is based, write SAE Special Publications. Price: 35¢ to members, 60¢ to nonmembers.

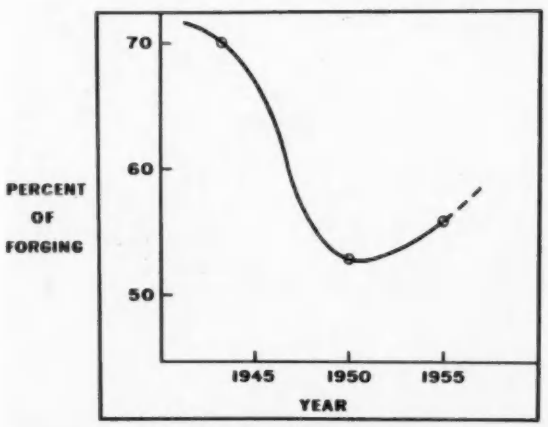


FIG.1 Forging weight remaining after machining

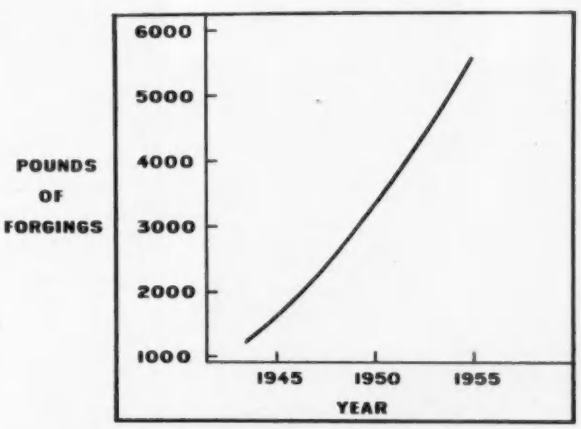
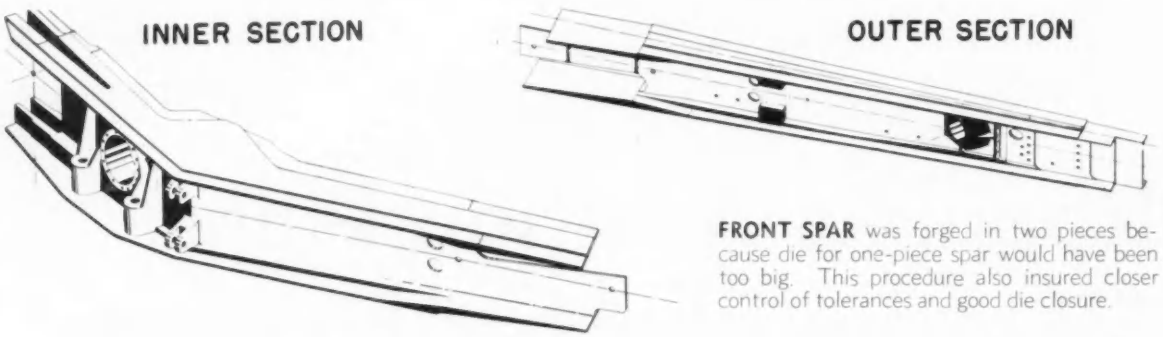


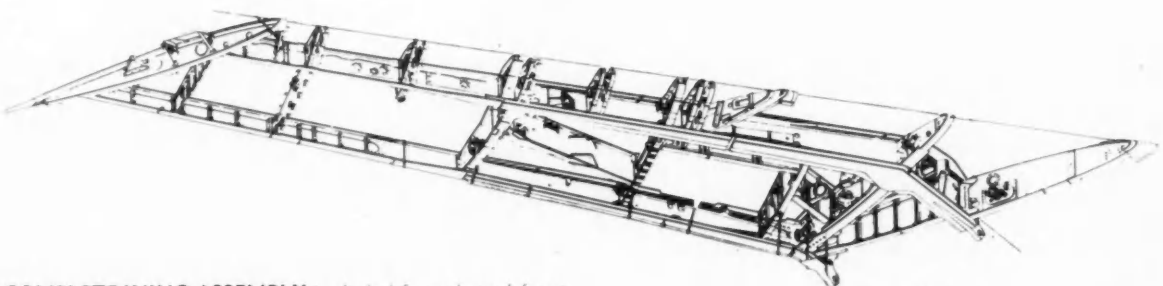
FIG.2 Forging trend at republic

Spars and Ribs Were Forged for the Swept-Wing F84F

WHEN F84 WAS REDESIGNED as F84F with swept wings, Republic found it cheaper to forge the spars than to machine and assemble them.

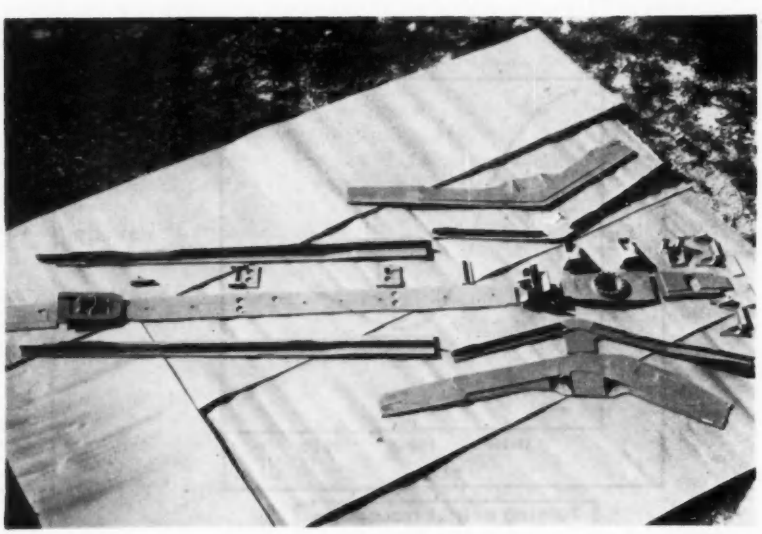


FRONT SPAR was forged in two pieces because die for one-piece spar would have been too big. This procedure also insured closer control of tolerances and good die closure.

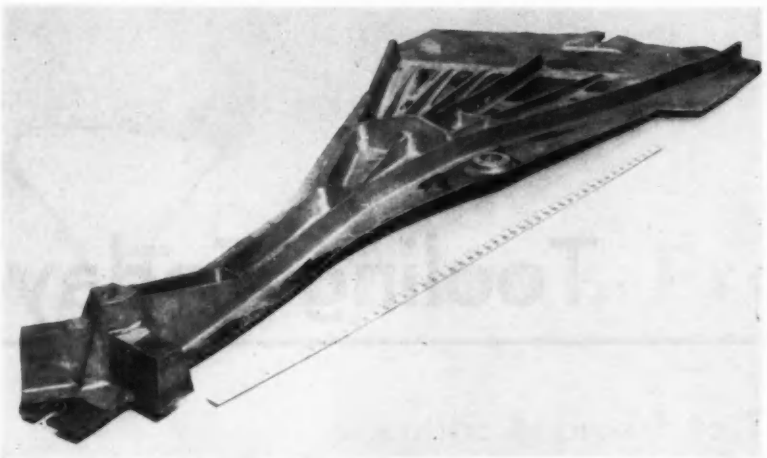


COMPLETE WING ASSEMBLY included forged steel front and rear spars, six ribs and an auxiliary spar forged of aluminum alloy, and forged steel wing hinges. Rib A was 6.7 lb lighter when forged, rib B was 12.9 lb lighter, rib C was 4.0 lb lighter, and the auxiliary spar was 7 lb lighter. These parts were designed in 1950 to be forged on Wyman-Gordon's 18,000-ton forging press. With today's better equipment and techniques, most of them could be designed for smaller draft angles, less weight, and less machining.

DIE for spar section is complicated.



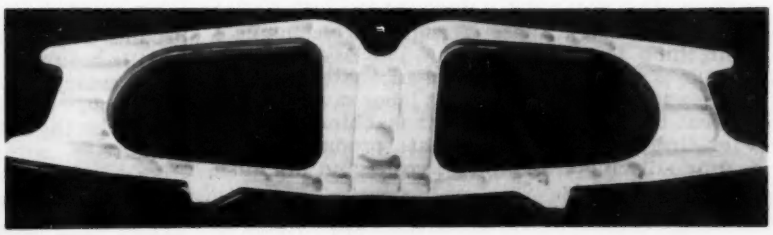
BUT forged front spar saved 74 lb over machined and assembled version above.

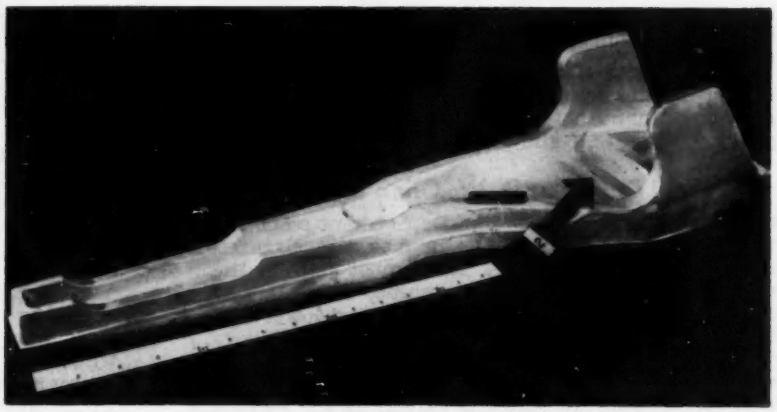


FORGED WING SPAR CAP (above and at right) forms part of the outer contour of the wing. It is 26 in. wide, 76 in. long, and 5½ in. deep at the deepest part. Skin, ribs, and formers are incorporated into a single part. Mechanical properties are consistently high, and skin as quenched is within 1/32 in. of required contour.

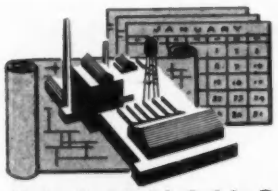
Wyman-Gordon ships parts in quenched condition. Republic hand straightens and ages them. Closer control of quenching can lessen still further the need for straightening, it is expected.

Newer Design Has 436 Forgings, Including These Large Pieces





THREE BIG FORGINGS above are among the 436—229 different ones—of aluminum and steel used in one fighter.



PLANNING for TOMORROW

Tooling Today

NEW production concepts and, in many companies, radical reorganizations are permitting closer control and more scientific planning of tooling practices. Result: more economic production.

- Many large companies are establishing manufacturing or production research divisions to investigate new processes and equipment that will reduce manufacturing costs.
- Both large and small companies are looking for a new "common sense" formula for economical machine tool replacement. The M.A.P.I. formula is no longer considered adequate for many situations. Requiring direct labor savings sufficient to pay for replacement machinery in two or three years could stagnate product design, gradually increase product costs, and diminish company assets.
- All companies are intensifying their efforts to coordinate and improve the operations of the Methods and Processing Departments, Tool Design, and Tool Rooms and communications between them. Cost Reduction Committees are being established.

These changes have required re-evaluation of responsibilities for the various tooling functions in relation to manufacturing. Here's what's been happening in five well-known companies:

Tool Design at D. W. Onan & Sons

ONAN makes the Tool Design Department responsible for developing machinery or dies, jigs, fixtures, and cutting tools. These tools must permit the production department to machine, fabricate, or assemble a product at better quality and lower cost than competitors.

However, Onan realizes Tool Design responsibility varies with the size of run and the type of the product. When manufacturing a variety of low volume products, Tool Design should be given greater responsibility in determining method, machines, and tools. When manufacturing larger volumes, methods and machines are often already established and Tool Design primarily designs the tools asked for.

Tools must be as universal and simple as possible. They should be designed so that they will not require excessive repair or require an unusually skilled operator. Properly designed tools can keep scrap and rework to a minimum.

Where old or worn machinery exists, tooling must produce the required accuracy in spite of this. This usually requires more expensive tooling than would be necessary if the machinery was in good operating condition. Cost and complexity of a tool is controlled by the volume and cost of the parts it must produce.

Tool Room at A. O. Smith Corp.

SMITH requires the Tool Room to produce quality tools at the lowest practical cost. At the same time, the Tool Room assists Tool Engineering and the Production Department in making the tools work. More specifically, the responsibilities of the A. O. Smith Tool Room are outlined below:

1. To make, alter or repair tools, to the Design Group's specifications, at controlled, adequate quality levels, on predictable delivery schedules, and at predictable costs.
   a. By establishing a close, harmonious working relationship with Tool Design.
   b. By maintaining an Inspection Group which has authority to accept or reject the product.
   c. By practicing Quality Control and high standards of craftsmanship to the point where parts requiring renewal are interchangeable or, at least, can be fitted with a minimum of idle time.
   d. By maintaining a realistic scheduling system, with appropriate "cushions" for the emergencies which are part of the business.

for Tomorrow's Production

Scientific Approach to Tooling Promises Lower Costs Through Production Research and Better Communications

F. J. Pryatel, Cletrac Division, Oliver Corp.

Based on secretary's report of the panel on "Tool Design, Tool Room, Methods Engineering—Their Relationship to Manufacturing" held as part of the SAE Tractor Production Forum, Milwaukee, Sept. 12, 1955.

   e. By estimating work, recording both estimate and actual cost, and tabulating this information for use as a guide in making future estimates.
2. To make these tools perform to the satisfaction of the production departments, collaborating with Tool Engineering as required.
   a. By taking the initiative in following up on the production floor, including making required changes, demonstrating the use of the tool, and aiding the production supervisor in training the operator.
   b. By aiding the shop in anticipating needed repairs or spare parts, and arranging for such work at the most convenient times.
3. To make the tools at the lowest possible cost.
   a. By assigning work to match individual's skills, according to operations or type of work.
   b. By working with Tool Engineering to bring about standardization of design and components.
   c. By developing standard procedures for doing repetitive jobs--including "Tooling" where necessary.
   d. By letting the worker know what hours have been estimated for a given job, and checking back with him to determine the causes for substantial overruns. (Consider having the worker participate in the estimate!)
4. To establish high morale and good labor relations.
   a. By recognition of ability through wages and promotions.
   b. By maintaining a clean, orderly shop.
   c. By encouraging use of trade literature, attendance of appropriate expositions and meetings.
   d. By maintaining a systematic training program for replacements.
5. To build the department for the future.
   a. By maintaining facilities in good repair, and having a systematic equipment replacement policy.
   b. By being aware of and experimenting with new methods, techniques and equipment, and being willing to cast out traditions for better methods.
   c. By developing the head of the department into a respected consultant to the production shop and top management on production problems.

Processing and Methods at Minneapolis-Moline Co.

MINNEAPOLIS-MOLINE recently changed its processing and methods operations to service the production department better.

Minneapolis-Moline now assigns a process and a methods engineer to each operation: foundry, machining, assembly, sheet metal, metal finishing, etc. Concentrating engineers in a specialized field, where they can gain an intimate knowledge of the problems, gives excellent results.

The reorganization established a Tools and Methods Department. Methods Engineering was removed from Time Study and became part of Tools and Methods. Tool manufacturing, tool cribs, inventories, plant layout, and material handling also

became part of this department. A Tool Engineer was given direct responsibility for tool design, tool room, and tool cribs. The Time Study Department was given the additional duties of estimating and controlling standards.

A typical sequence of procedure through this Tools and Methods Department is as follows:

1. A drawing and methods card is released by the Product Engineering Department to a general process and methods engineer. He is the Manufacturing Division representative in the Product Engineering Department. He checks the drawings to determine whether the designs are consistent with good manufacturing procedures and methods. He may have made design recommendations to the engineers prior to this time. When he is satisfied he releases them to the process engineer of the appropriate manufacturing plant.
2. The process engineer reduces the part to a sequence of individual operations and determines in this sequence what machines will do the job, determines the availability of tooling as well as additional tool requirements. On new or complicated parts, a conference between the process, methods, tool engineers, and department foreman may be held. It is then released to the methods engineer. In most cases the quantity will determine the type of process.
3. The methods engineer determines the speeds, feeds, strokes, or any other technical functions that are necessary to produce the required quality in the least amount of time. He also reduces assembly operations to the individual operations and stations, and determines line lengths and line speeds. He determines the positioning of the tools or fixtures, positioning of the material at the operator and machine, and the method of handling material from one operator to another or from one machine to another. At all times he considers safety and quality. The methods engineer can question a process and make recommendations and consult with the tool engineer, material handling, and plant layout engineers to be sure he has developed the method most efficiently. He then passes the job on to the tool engineer.
4. The tool engineer determines the tooling requirements and develops the designs. The design is in many cases developed through consultation with foremen, superintendent, and others. The tool engineer then forwards the card to the Time Study and Standards Department.
5. The Time Study and Standards Department estimator analyses the operations, process, method, and tooling, and estimates the cost of the operation. The estimator still can question or make recommendations on any of the processes, methods, or tool and fixture designs.

After the tooling is designed and released to the tool room, the tool engineer controls the manufacture of that tool through the tool room supervisor. The tool engineer sees that the tool is manufactured to the specifications outlined in the tool design drawings and inspects the tool or fixture before it is released to the shop for tryout purposes. He is also responsible for the completion dates of all tooling.

After the tooling is released to the shop for production, the methods engineer checks the job to be sure that it is consistent with predetermined procedure. Up to this point everything has been estimated, and it is quite possible that an error of judgment could have been made. Therefore, the methods engineer checks the job. If he is satisfied that proper feeds and speeds are used which will produce pieces at the greatest efficiency and still maintain normal tool life, the job is turned over to the production department.

Minneapolis-Moline's records indicate that since changing the organization they have continually reduced the cost of their operations.

Research at International Harvester Co.

INTERNATIONAL HARVESTER has set up a special manufacturing research group to keep up with new manufacturing methods. It has three primary functions:

1. To conduct research concerning technical manufacturing activities of all kinds, and keep up with technical progress throughout the world.
2. To formulate standards of manufacturing practices to be followed by the company's various divisional manufacturing departments.
3. To conduct manufacturing operations research directed toward continual study and improvement of the organization and management of Harvester manufacturing activities.

Some basic research is also conducted. In addition to reductions in cost, other benefits are realized, such as:

1. Improvement in quality. Cost reductions are not made unless their normal high quality is maintained or improved.
2. Elimination of drudgery types of labor operations.
3. Improvements in working conditions by means of Safety Engineering.

This Research Division has 14 operating sections, some of which have extensive laboratory facilities. In addition to their own shop and laboratory activities these people work with the various International Harvester plants, outside industries, technical societies, universities, and federal agencies.

Problems or ideas may be directed to Manufacturing Research from any of the International Harvester Works. Some may originate in the General Office administrative personnel. Many originate at Manufacturing Research itself. Such ideas are screened by the Research Committee composed of section heads and research management. If these ideas have sufficient merit, they are referred to the proper section.

A major study of a particular new machine or manufacturing process is set up as a long term program. A program may be sub-divided into individual items which are set up as relatively short-term projects. Trouble shooting for any of the International Harvester operations is handled as a service account. The development of engineering test samples of proposed new designs or new materials on an old design would be handled similarly.

At the conclusion of each problem a final report

is written and circulated to the plants most likely to be affected.

In addition, a bi-monthly bulletin containing selected new ideas and developments that have been put into effect at the main plant is sent to other plants. New methods, processes, or designs from one section are distributed to personnel at other sections and plants on a form called "Informative Bulletin."

Manufacturing Research also sponsors company-wide committees to discuss subjects of mutual interest and exchange information. Most phases of manufacturing are covered by the following committees: Inspection, Foundry, Forging, Welding, Materials Handling, Mechanical Engineering, Plant Engineering, and Metallurgy. Duplication of research and experimental work has been thus reduced to a minimum.

Communications at Minneapolis-Honeywell

MINNEAPOLIS-HONEYWELL Regulator Co. has established a Methods and Industrial Engineering Department that greatly facilitates the exchange and flow of ideas and tooling techniques. A time study section, which had been abandoned during the war, was re-established under the Chief Methods Engineer.

In addition, a section called the Process Group was established which is composed of the most experienced men in the various arts of component manufacture and assembly. These men act as consultants and advisers. They are often assigned to specific design projects, and incorporated into the design team. This assures an interchange of ideas at an early stage of product design.

The Process Engineer has full responsibility for the manufacturing processes of the product as well as the manufacturing costs. These responsibilities are:

1. Assist designers in developing the product.
2. Prepare preliminary and final tooling and factory cost estimates.
3. Prescribe the tooling and detailed processes of manufacture.
4. Prescribe the necessary gages.
5. Interpret and transmit all product design information to all manufacturing activities.
6. Supervise a trial run of tools and processes and obtain agreement from foremen and inspection that the process is satisfactory.
7. Recommend provision of new facilities.
8. Continue to maintain liaison with product design, factory methods engineers, and all others who have responsibility with manufacturing activities.
9. Develop new processes and methods when required.
10. Keep abreast of new techniques, processes and equipment as they appear on the scene.

The Process group is supplemented by a group of factory methods engineers assigned to the various manufacturing and assembly areas. These engineers maintain and improve the processes originally provided, give technical assistance to the Operating Department to which they are assigned, and continually seek means for reducing operating costs.

A Standards Group was also established in the Methods Department which was comprised of design engineers, methods engineers, factory contact engineers, inspectors, and tool designers. It was their purpose to develop standards of design and manufacturing for the guidance of all Minneapolis-Honeywell divisions.

Each major division has its own Standards Groups which meet semi-annually with the parent group at Minneapolis.

Two standards books were compiled: the *Engineering Standards Book*, and the *Production Standards Book*. The *Engineering Standards Book* contains standards covering:

1. Drafting practices
2. Design recommendations
3. Unwritten and implied tolerances

The *Production Standards Book* contains standards covering:

1. Print interpretations
2. Machine specifications
3. Standard tooling
4. Tool design data
5. Production data, such as bend allowances, tap drill sizes, speeds and feeds, and other information useful to Tool Design, Tool Room, and Production.

Machine and Tool Research Group was established to keep abreast of the latest developments in the machine tool field. It also conducts research on cutting tools, tool life, tool lubricants, and other related items.

(The secretary's report on which this article is based is available in full in multilith form together with reports of the 7 other panel sessions of the 1955 Production Forum held at the SAE Golden Anniversary Tractor Meeting, Milwaukee, Sept. 12, 1955. This publication, SP-312 is available from SAE Special Publications Department. Price: $1.50 to members; $3.00 to nonmembers.)

ON THE PANEL which developed the information in this article were:

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F. J. Pryatel, panel secretary
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A. H. Eggert,
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A. O. Smith Corp.

E. G. Leverene,
International Harvester Co.

C. I. Burdick,
Minneapolis-Moline Co.

Paul Clark,
Minneapolis-Honeywell Regulator Co.

4 questions industry is asking about . . . . . Tomorrow's

1. How Do We Select and Develop Supervisors and Specialists?

The selection and development of supervisors and specialists are becoming more and more important each day. Unless these people are especially talented, and unless a sound selection program is followed, they will not do the job. There must be a sound balance between the educational background and experience of our candidate. Both should be developed to the optimum. Keep in mind that supervisors and specialists are not selected every day.

Adequate training programs should be in existence to aid in the development of personnel. **With the competition in today's industry, a good supervisor must run to stay where he is, and must run twice as fast to advance.** Development should be individualized as much as possible with a proper balance of the technical and non-technical. Give a supervisor a voice in his own development program. Too often this is not done. Consider the factor of developing people within their own development—in other words, help them to run to meet their goal.

In the selection of a supervisor one should completely as possible analyze what he is looking for, realizing that all people cannot grow—some will remain to do a specific job. It is well to use company talent as much as possible. However, do not avoid entirely good talent from the outside.

Tests, both achievement and clinical, might be used as an aid for selection of your candidate. Years of service should also be considered, keeping in mind that years of service alone does not qualify a man for promotion. The old method of the boss evaluating the man usually falls short of the goal in modern industry.

2. Can Specialists Be Good Supervisors?

A good supervisor is one who can get the desired results from the group he supervises. His effectiveness is measured directly by the results produced by his group, whereas the specialist is one who is technically qualified in the methods, machinery, or application of the process involved in any given area of operation.

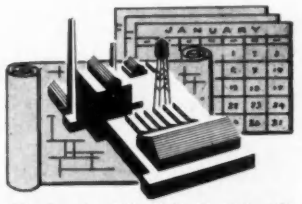
A supervisor must have enough technical know-how, possibly supplemented by staff assistants, to understand thoroughly the operation under his supervision. He must have an appreciation of the problems of other departments and other supervisors on his own level with management. He must be able to operate as a member of a team, that is, a supervisors team, and he must be able to mold the workers of his department into a smoothly operating, harmonious team.

For a specialist to be a good supervisor, he must be able to pass on to his workers enough technical know-how to maintain interest and team spirit. He cannot be a one-man show who insists on making every decision himself. Perfectionists, usually, make poor supervisors. The attempt to do a job perfectly results in not meeting production schedules. The good supervisor is human relations minded—can build a team—can get along with other supervisors —is a good team member for his own boss.

We must train our engineers, who are normally not human relations minded, to understand the people they supervise so that they may better administer their jobs as supervisors. We can do this by exposing these men to human relations courses. Better yet, this training could be given in college, perhaps by extending college engineering courses to five years to include human relations and other administrative courses. Best results could thus be attained, as experience has shown that these subjects are better accepted with the young engineers.

Frank Fiore, Personnel Manager, Massey-Harris-Ferguson, Inc.

Based on secretary's report of panel on "Are We Properly Evaluating Future Supervisors and Specialists" held as part of the SAE Tractor Meeting and Production Forum, Milwaukee, Sept. 12, 1955.



PLANNING *for* TOMORROW

Supervisors and Specialists

3. How Do We Evaluate and Pay Supervisors and Specialists?

This is most difficult and unscientific; there is a great deal unknown about such evaluation. In appraising, we must ask, "What is their job?" Even this is difficult, because many times even the man himself does not clearly understand entirely the scope of his job.

The distinction between a supervisor and a specialist is as follows. A good supervisor derives satisfaction from the work of other people and must have enough technical ability to know that his group is doing the job. He must have an excellent knowledge of human relations. And, he must be able to sell the performance of his subordinates to the upper echelon or top management.

A specialist must be an expert technician. His knowledge of human relations is desirable, however, not entirely necessary. He must be able to sell ideas to his own group. A top technical man can be the counterpart to the division head or supervisor. The technical man should be able to report to someone for administration, and his pay must be commensurate with his action and accomplishment as well as his potential. His pay should not be based on potential alone. Specialists should be afforded the same treatment as supervisors and it may be well to keep in mind that they will compare their salaries.

Companies usually grade jobs according to the level of responsibility and the skill required to perform the job. Be careful! Graded jobs may turn out to be a Frankenstein if proper job evaluation is not performed.

CONTINUED ON NEXT PAGE

The Experts

The material on the evaluation of future supervisors and specialists contained in this article is based on a panel discussion by the following experts:

Panel Leader:

Dr. Milton Gordon,
Associate Director, Management Center, Marquette University

Panel Secretary:

Frank Fiore,
Personnel Manager, Massey-Harris-Ferguson, Inc.

Panel Members:

R. W. Ells,
Chief Economist, Allen Bradley Co.

A. G. Hall,
Works Manager, Nordberg Mfg. Co.

J. E. Conway,
Director, Education and Training A. O. Smith Corp.

J. C. Crout,
Director, Battelle Memorial Institute

R. W. Lanman,
Psychologist, Humber, Mundie and McClary

4. Are Supervisors of Supervisors and Specialists Born or Developed?

This might be answered half and half. There must be certain physical and natural attributes, such as appearance, intelligence within limits, and personality. Personality should be a part of the man before he is chosen. Don't attempt to make major personality changes.

Our supervisors' supervisor must have a knowledge of the job, accompanied with the specific supervisory skills. He cannot be expected to be proficient in all aspects of the job, but he must at least be conversant with the field. A man who is to be developed for long-range planning cannot be too technically minded. He must leave his technical field to a point to concentrate on administration.

The report on which this article is based is available in full in multilith form together with reports of the six other panel sessions of the 1955 SAE Production Forum. This publication, SP-312, can be obtained from SAE Special Publications Department. Price: $1.50 to members, $3.00 to nonmembers.

Learning Curve Theory . . .

. . . provides a valuable tool for estimating, forecasting, and controlling costs in aircraft production. It could be used profitably by other industries, too.

Based on paper by **Robert H. Lundberg,** Chance Vought Aircraft, Inc.

LEARNING curves provide an aid in estimating labor costs for submitted bids, for forecasting shop labor loads, planning manpower needs, scheduling work flow, and many other purposes.

In addition, the learning curve of labor costs can serve importantly during a given production quantity run by enabling comparison to be made between actual performance and estimated performance. Causes of malperformance can be located and corrected when they occur rather than when the run is completed and money has been lost.

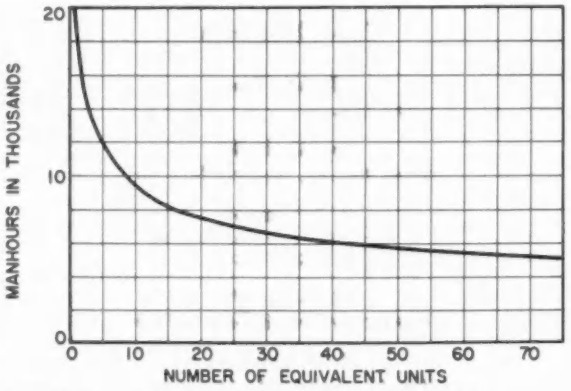


Fig. 1—This 80% learning curve, which shows the cumulative average cost trend, is typical for the aircraft industry. Its significant features are the high initial cost, rapid cost reduction at the outset, and tapering off to attain a fairly stable condition.

Although established for aircraft production, the principles controlling learning curves are common to any "custom-made" production, medium quantity production, or even mass production. And knowledge of the factors influencing learning curves is the key to understanding production labor costs.

The learning curve can be established by plotting a series of cumulative average production labor costs (in dollars or man-hours) of a particular product on linear graph paper against the number of articles produced (Fig. 1). (Cumulative average cost is found by dividing cumulative cost for production labor by the number of units produced.) This curve is typically hyperbolic in shape. So when it is plotted on logarithmic graph paper it approximates a straight line as shown in Fig. 2. For all practical purposes this curve may be considered as a straight line over the normal range of aircraft production quantities.

The most impressive features of this learning curve are the very high initial cost and rapid rate of reduction in the early portion, with a gradual tapering off in the latter portion, until a fairly stable condition exists. Several factors cause this behavior pattern. Divided into two groups for the sake of convenience they are: (1) those due to certain conditions permitted by the quantity of units produced, and (2) those due to normal improvement made in cost performance during the production of any given quantity.

For further clarification, consider for the moment the article whose production cost performance es-

tablishes the curve. The article has designed into it a certain complexity and a certain number of things which must be done by some combination of men, tools, and machines to produce it. The work allocated between men, tools, and machines can be varied within a wide latitude for any given quantity to be produced. Increased tooling generally reduces the man-hours of work, but it requires a sizeable initial cost which must be prorated over the articles produced. If only a few are made, the savings in labor cost usually do not offset the increase in total cost.

A similar situation exists when high quantity production is approached and special purpose machines are considered to replace tooling and further reduce manpower requirements. Costs cannot be controlled without some degree of administrative planning and scheduling. The matter of degree is important. The minimum cost for performing a certain operation can be predetermined through planning, while further planning and scheduling can assure its attainment. This is very involved and expensive since even the simplest part can be made most economically only in very large quantities. The minimum quantity warranting such action is a function of the complexity of the article, its intended cost, and the time permitted for planning and scheduling. A more general approach is needed as the quantity decreases, complexity increases, or the time permitted for planning and scheduling decreases. As a result, the work done by men becomes more complex and costly, and without rigid cost control, higher cost is certain.

In the case of small quantity production, a few articles have to bear tooling and administrative costs. To keep these costs from becoming excessive, tooling and master planning must be restricted to the minimum. Therefore, shop labor must cope with the complexity of the article and a substantial portion of the actual production must be done by men rather than by tools and machines. Further, since it is uneconomical to master plan and apply rigid controls, inefficiencies are bound to occur in production labor, tooling, machine use, and the like, with resultant fairly high cost.

On the other hand (if the delivery schedule for the first production item permits) with an increase in the number of articles to be made more tools can be used to reduce the complexity of work done as well as reduce the amount of production labor required. As more master planning is allowed, a system of controls may be developed to assure greater efficiency in use of labor, materials, machines, tools, and work routing to effect a further reduction in cost.

The foregoing illustrates that the quantity of articles to be produced is one of the main factors in determining the shape of the learning curve for labor cost versus quantity, since it controls the amount of effort and means employed to reduce complexity and place the burden of production on machines and tools rather than men.

Cost performance may always be improved during production. The gain may be slight over the entire production of a very large quantity, while with small or medium quantity the reduction may be very substantial in early production and taper off gradually until a stable cost is attained. This reduction due to learning involves improvement in such things as job knowledge by shop personnel, manpower allocation by management, design changes, correction of tools, and general adjustment throughout the organization. Thus, the amount of learning which takes place during production also influences the shape of the learning curve for labor versus quantity.

In aircraft production the time between receipt of contract and delivery of the first airplane usually does not permit complete production engineering and planning. It is often necessary to begin with a minimum of tooling and add to it. Meeting delivery schedules and coping with design changes make difficult the scheduling of manpower and work flow and the stabilizing of shop labor. When this is the situation and the cumulative average direct manufacturing labor costs are plotted against the corresponding unit numbers, as in Fig. 1, a definite pattern is observed. The pattern is about the same for all aircraft and is the basis for the theory of the 80% learning curve which holds that each time the quantity of planes is doubled, the cumulative average cost will be 80% of the cumulative average cost at the quantity which was doubled.

While the 80% curve is a good practical average learning curve for aircraft, the relative complexity of the design usually results in a slightly different actual performance. The more complex the article, the higher the initial cost and the faster the rate of reduction. Conversely, the simpler the article, the lower the initial cost and the slower the rate of reduction. (Paper "The Learning Curve Theory as Applied to Production Costs" was presented at SAE Annual Meeting, Detroit, Jan. 12, 1956. It is available in full in multilith form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

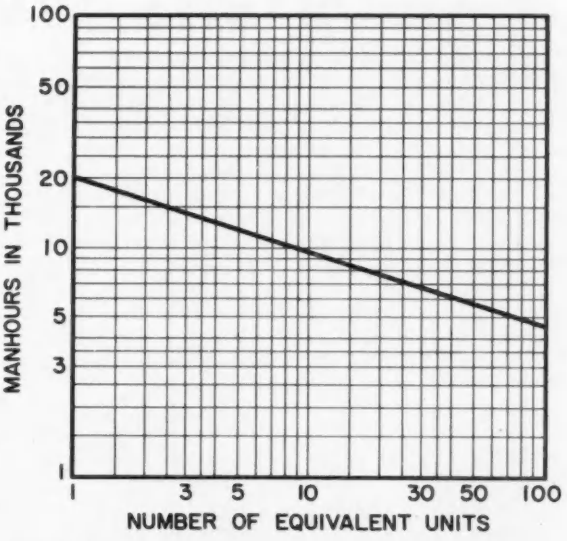
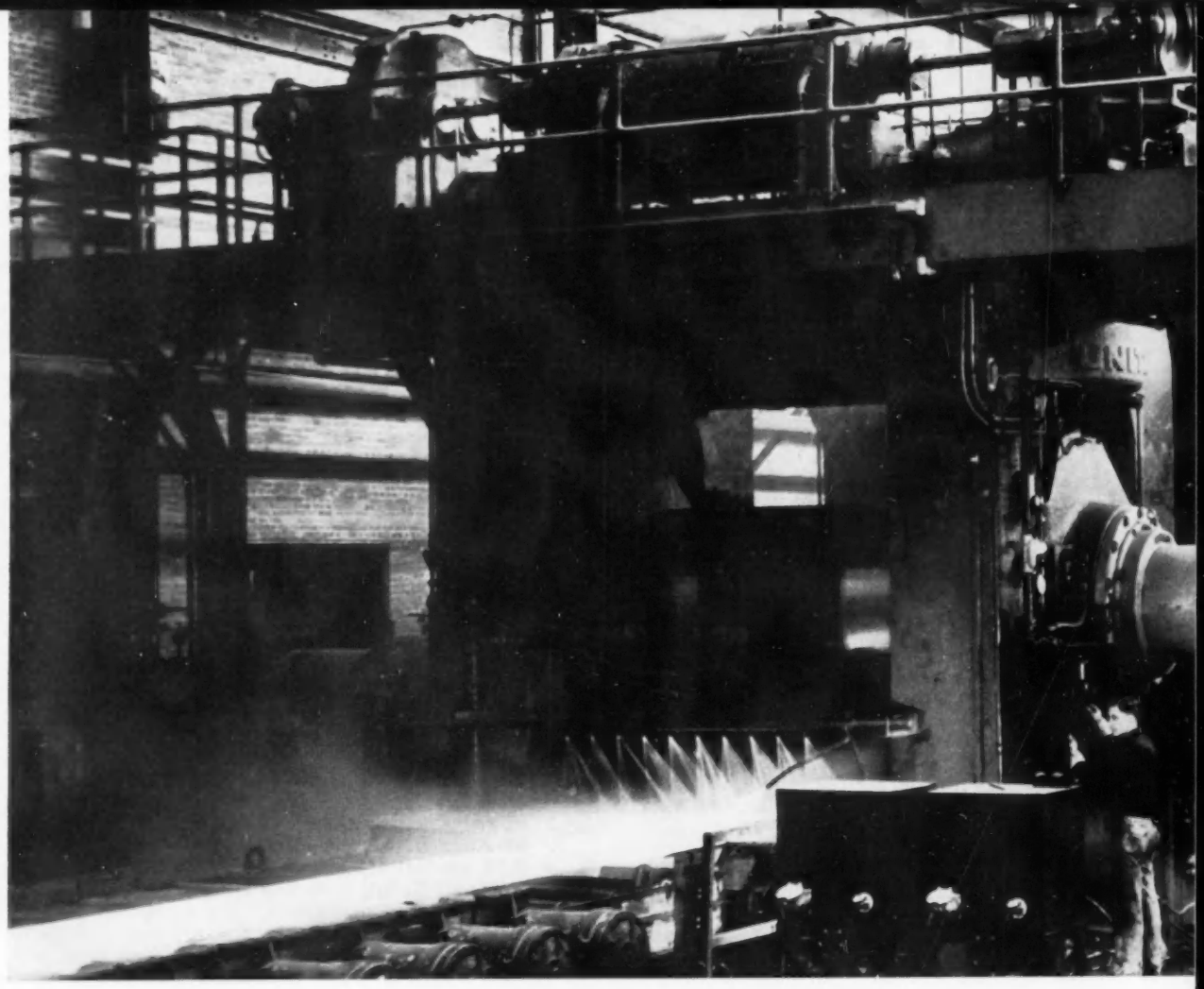


Fig. 2—When a learning curve is plotted on logarithmic graph paper a straight line is obtained which is representative of the normal range of aircraft production quantities. Learning curves can be used for estimating, forecasting, and checking actual against estimated performance.



SAE Visits World's Widest

STEEL for automotive use was rolled on the world's largest strip mill before the eyes of SAE engineers during the 1956 SAE Production Meeting in Cleveland. The visit to Republic Steel's recently expanded Cleveland District plants was made on March 14. The visitors were told that Republic is planning for even greater production capacity in the future by continuing to install new steel-making equipment and facilities.

The SAE members saw slabs of steel from a blooming mill being fed into a continuous hot strip mill 98 in. wide, the largest of its kind in the world. It has a capacity of more than 160,000 tons of steel every month.

Before rolling, the slabs are heated to about 2300 F. As a slab enters the first stand of rolls (see above picture) it is hit with a high pressure stream of water which removes iron oxide scale.

The slab is reduced in thickness and increased in length as it is rolled through four roughing stands and six finishing stands. By the time it emerges from the last stand it is a long thin ribbon a quarter mile long, travelling at a speed of 25 mph.

The strip is coiled by an electrically-operated coiler and removed from the mill by power-driven conveyors.

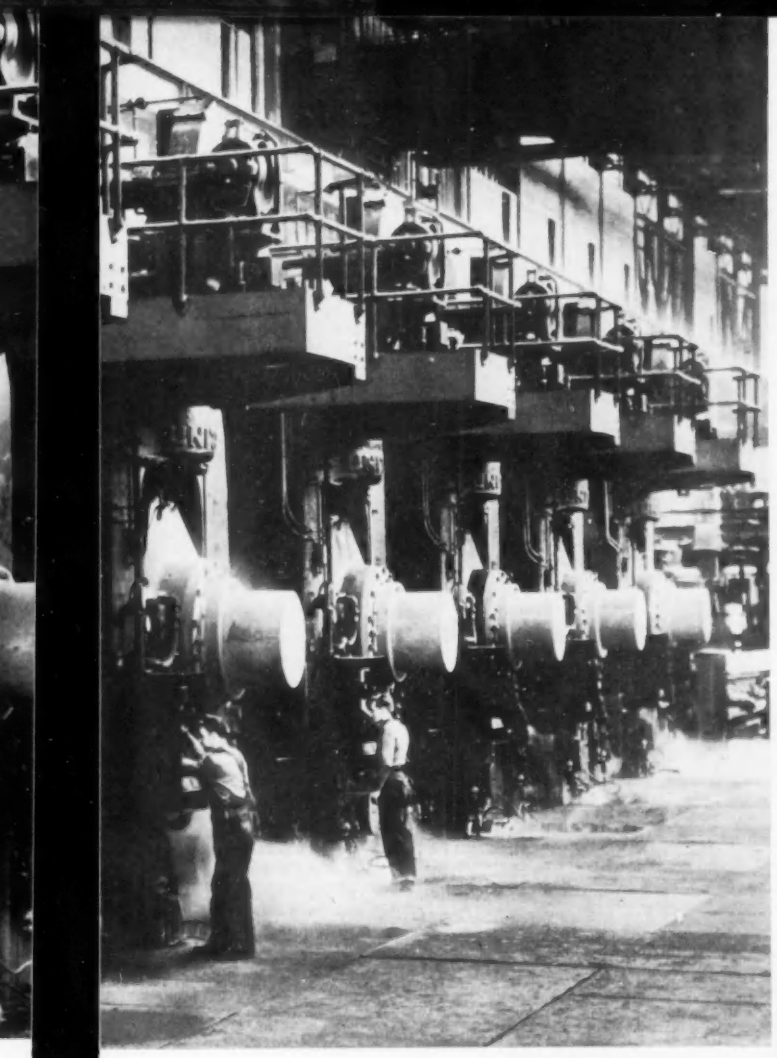
Much of the hot rolled steel is shipped to the automotive industry. The balance goes to the cold mills for further processing.

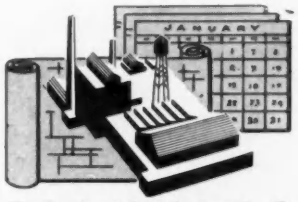
Before cold rolling, the steel is pickled in acid baths to remove scale. Then it goes to either the 98-in., 72-in., or 54-in., cold reducing mills. Each rolls the strip to the thickness and surface smoothness specified by the customer.

The steel is annealed in controlled annealing furnaces from which air is excluded to prevent oxidation. This heat relieves internal strains and brittleness induced by cold rolling. After annealing much of the steel is temper-rolled, which gives it such hardness as the customer ordered.

The steel is shipped to the customer either in packaged coils or flat sheets cut from the coils.

The large capacity of Republic's strip mill is a result of far-sighted management planning which turned profits back into the business, expanding raw materials resources, modernizing plants, and improving efficiency.





PLANNING *for* TOMORROW

RED HOT STEEL ribbon roars from Republic's 98-in. strip mill—the largest of its kind in the world. Plans are underway to increase steel production capacity more than 792,000 net tons in the Cleveland District plants by 1957. Improvements will include two new open hearth furnaces, a new slabbing mill, new soaking pits, a new heating furnace for the 10-in. bar mill and general modifications.

Strip Mill

In an expansion program which ended in 1952 these major facilities were added:

- Four open hearth furnaces
- A 1,470-ton blast furnace
- A by-product coke plant consisting of 126 coke ovens
- A 72-in. four-stand, tandem, cold reducing mill
- A 72-in. temper mill

A current program expected to increase capacity 792,000 net tons by the end of 1957 will:

- Add two new open-hearth furnaces, enlarge the four built in 1952, and improve some of the older furnaces
- Build a new slabbing mill
- Add new soaking pits
- Add a new heating furnace for the 10-in. bar mill
- Improve many other facilities including the 98-in. strip mill

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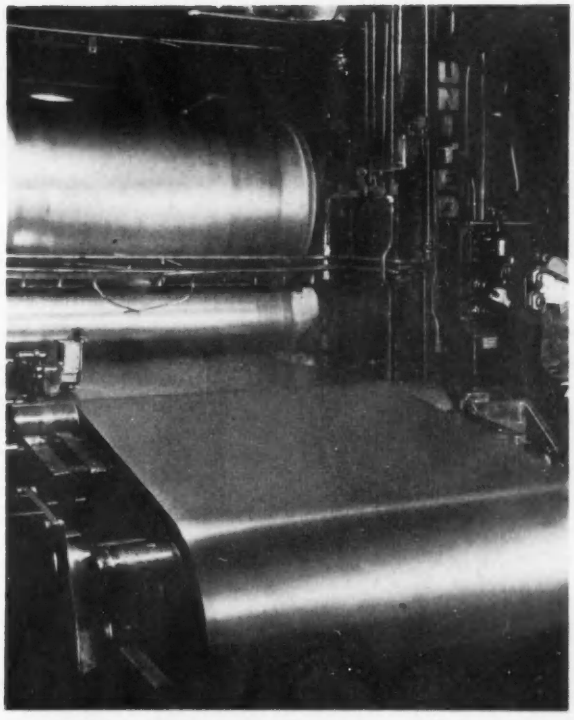
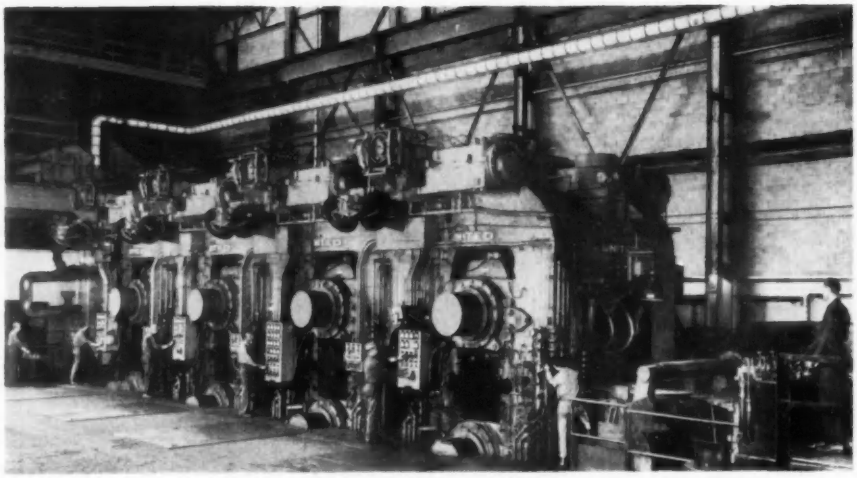


AFTER ACID BATH the steel strip is passed through this cold reducing mill which rolls it thinner and harder and gives it a smoother surface.

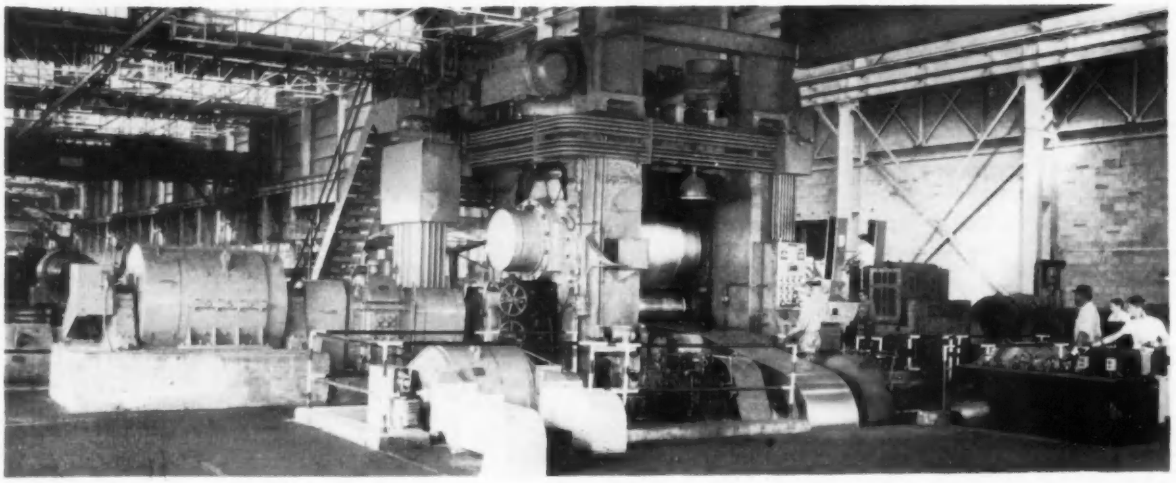
SAE VISITS STEEL



72-INCH cold rolling mill is one of three already installed as part of the Cleveland expansion. Automotive industry is a major user of smooth surface, light gage steel.

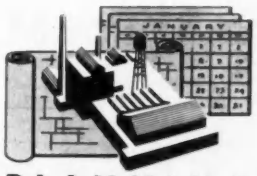
STEEL IS SOFTENED by heating in box anneal plants. Coils are put in corrugated cylindrical containers which are covered with closed box-like containers and heated without oxygen.

SKIN-ROLLING in this 72-in. temper mill gives the steel coils the hardness that the customer desires. Previous annealing has relieved the internal strains and brittleness which results from cold rolling. The steel is shipped to the automobile manufacturer either in packaged coils or in flat sheets sheared from the coils. **END**



Four Recipes for Using

Plastics in Tooling



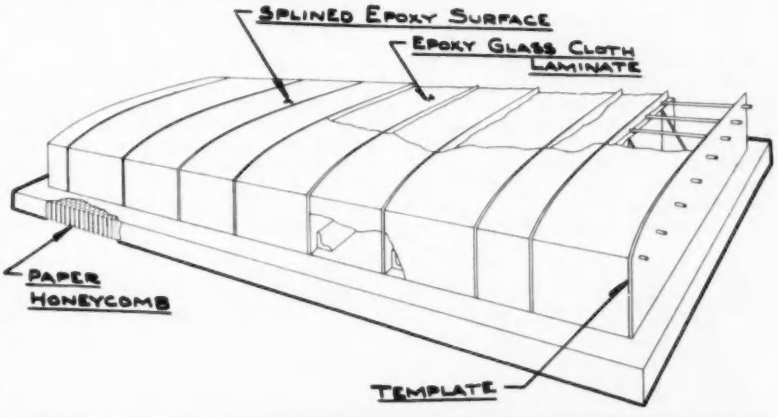
PLANNING *for* TOMORROW

M. M. Gilman, Tool Engineer, North American Aviation, Inc.

Based on panel secretary's report of the Plastic Tooling panel held as a part of the SAE Aircraft Production Forum, Los Angeles, Oct. 11, 1955.

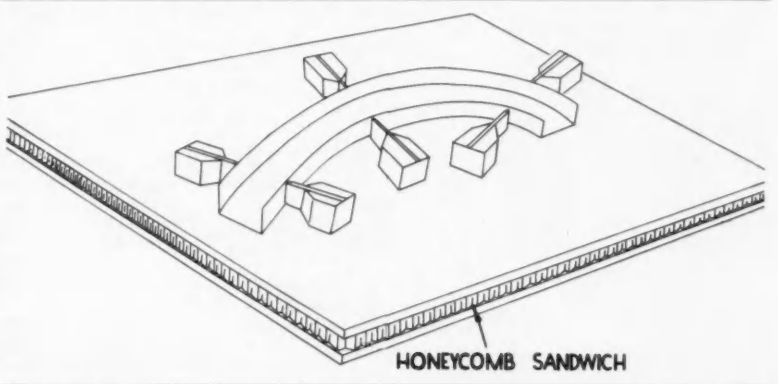
℞ 1. For Making Basic Master Models

- Cut templates to contour.
- Drill holes for rods about 5/16 in. inside the contour edge.
- Insert the rods and space the templates properly along the rods.
- Lay wire mesh over the rods if the subsequent layup is going to be heavy enough to require this added support.
- Lay several layers of fibrous glass cloth impregnated with epoxy resin over the wire mesh (or directly on the rods if no wire mesh is used).
- Spread troweling epoxy over the cloth-plastic layer to build up the mass to within about 1/32 in. of the finish contour. Allow this layer to cure.
- Roughen the cured troweling epoxy with sandpaper and apply a coating of special splining epoxy, fairing it between the templates. This will give accurate contours.



℞ 2. For Making a Check Jig

- Start with a base made up of two sheets of glass cloth and plastic laminate stiffened with phenolic-impregnated paper honeycomb. This sandwich gives a light weight, rigid, sturdy base.
- Sandblast the part of the locator that will be encased in plastic as shown in the illustration. This makes for a good metal-to-plastic bond.
- Place the master part on the base.
- Position the steel locators at appropriate intervals.
- Form a trough around each locator and fill it with an epoxy to hold the locator in place.
- Remove the master when the epoxy has set, and you have an inexpensive, light-weight, easily stored drill jig.



Rx 3. For Making Electrically Heated Epoxy Molds

• To start the making of electrically heated epoxymolds for the heat curing of polyester laminate parts such as radones—or for the contact forming of acrylics—dry the plaster master three days in an oven held at 110–130 F.

• Estimate the power requirements for the electrical heating system. To maintain a maximum 300 F temperature on a 220-v line, it takes approximately 2.5 w per sq in. of tape surface area.

(For a typical radome mold with a 36-in. base diameter and a 39-in. depth, it takes six 102-in. lengths of 1-in. tape and eighteen 76.5 in. lengths of 2-in tape. Total tape area is, therefore, 3366 sq in. Based on a watt density of 2.5 w per sq in., 8415 w are required—or 38.3 amp on a 220-v line lead.)

• Burn off all excess sizing on the tapes by keeping them in a 500 F oven for 1–2 hr.

• Impregnate the tape using a non-filled high-temperature-resistant epoxy resin with a room-temperature hardener.

• When the master is thoroughly dry, spray it with several coats of vinyl lacquer to provide a moisture barrier.

• Spray on a film of polyvinyl alcohol and let it dry thoroughly.

• Follow with a thin coat of wax.

• Apply 1/16 to ⅛ in. of catalyzed aluminum-filled high-temperature-resistant epoxy resin. Allow to gel. (The aluminum filler minimizes shrinking. However, aluminum-filled epoxy resin conducts electricity unless the resin is properly cured.)

• Lay up two layers of fibrous-glass cloth impregnated with the same high-temperature epoxy resin.

• When the resin begins to be firm, imbed the previously prepared electrical tapes. For a radome mold, start the tape layout at the apex, using a 1-in. section of tape of which the weft chords are cut enough to let the tape be spiraled around the mold and conform to the contour. Space the tape windings about ¼ in. apart. Use the 2-in. tape where the contour is not severe.

• Silver solder leads to each tape section and check electrical continuity of each tape as soon as it is impressed into the layup.

• Imbed thermocouple tips into the resin at appropriate points between the tapes. (The thermocouples give temperature readings used for heat control.)

• Coat tapes, thermocouples, and entire layup with the aluminum-filled high-temperature epoxy.

• Apply several more layers of fibrous glass cloth impregnated with the filled epoxy, leaving leads for tapes and thermocouples free.

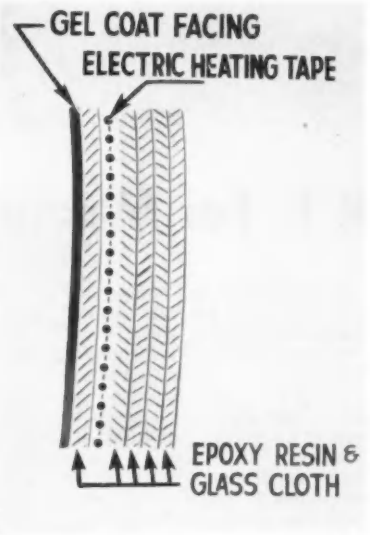
• Group tape leads into bundles and silver solder them in parallel to single leads. Coat all exposed wiring with ⅜ to 1 in. of filled epoxy resin. Connect to power sources and recheck electrical continuity.

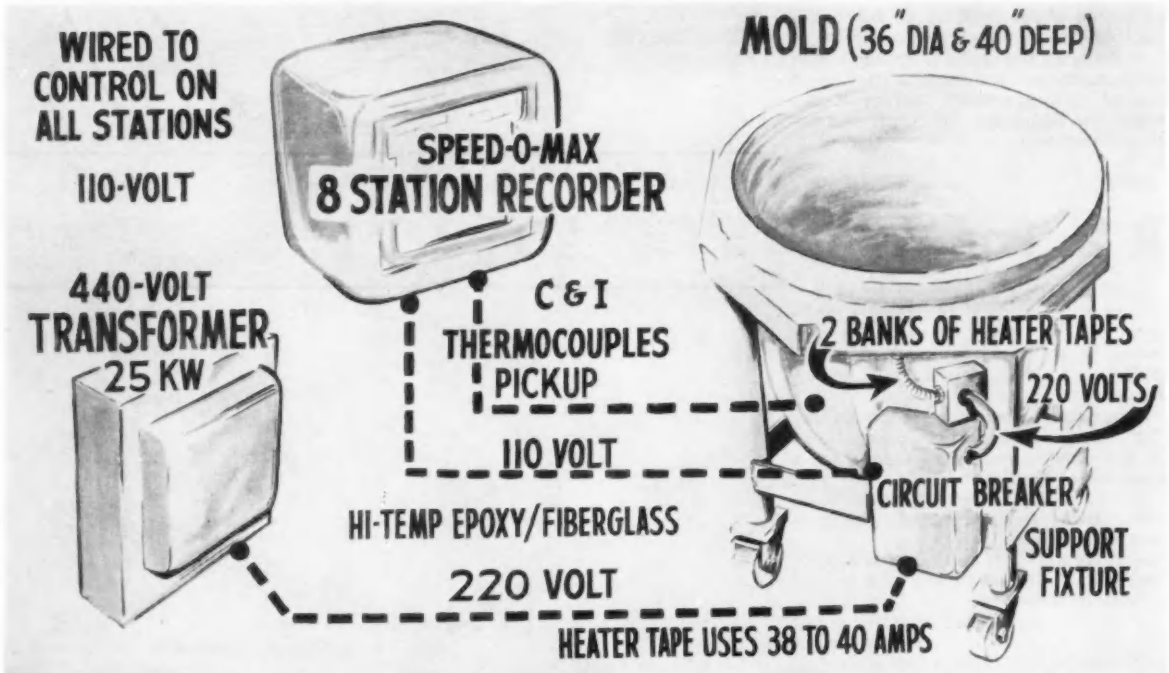
• With the plaster mold still in place, cure at room temperature for 24 hr, then in an oven. For the radome, keep the mold in an oven for 2 hr at 100–110 F, then 1 hr at 120–130 F, and finally 1 hr at 150–160 F.

• Remove the plaster master and post-cure. Give the radome 1 hr at 200–220 F, 2 hr at 300–320 F, and 2 hr at 400–425 F.

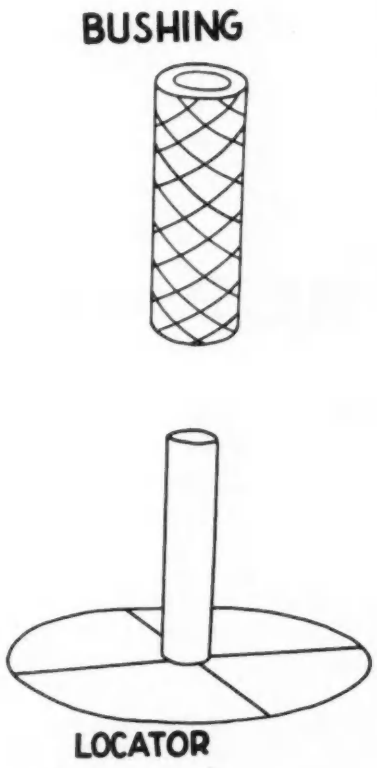
• Cool in an oven to minimize thermal shock.

• Complete electrical connections.





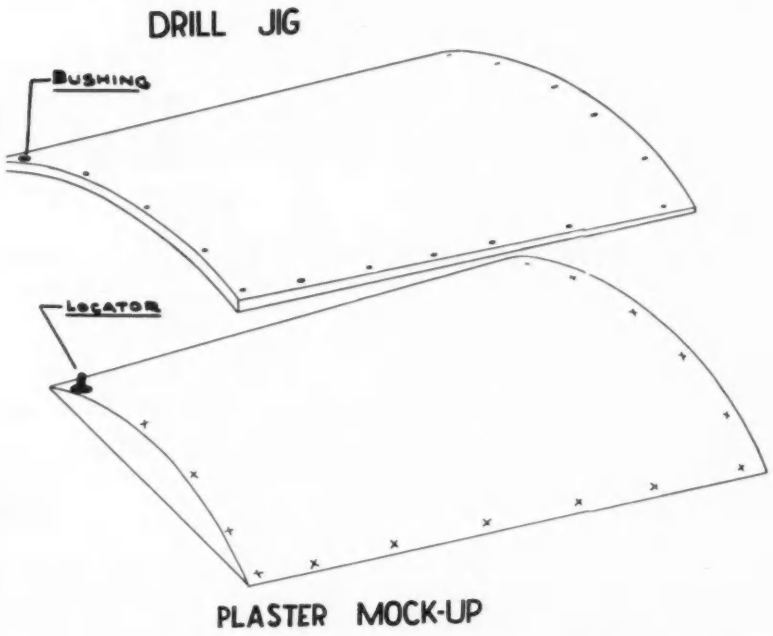
Rx 4. For Making a Drill Jig



• Start with locator and bushing units like those shown. (The locator has a flexible base that will adjust to the contour of the plaster mock-up. It has cross marks which make it easy for the user to position the locator exactly where the cross on the mockup indicates. The bushing is knurled on its outside diameter so that the laminate will adhere securely.)

• Glue the locators accurately to the mockup.

• Place a bushing on each locator. Then proceed with the laying on of the glass cloth and the plastic layers in the usual way.



The information presented in this article was developed by a panel consisting of:

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The report on which this article is based is available in full in multilith form together with reports of the 14 other panel sessions of the 1955 SAE Aircraft Production Forum. This publication, SP-313, can be obtained from SAE Special Publications Department. Price: $2 to members, $4 to nonmembers.

Machining By Tape

INDUSTRY's need for flexibility in short run production schedules will make good use of a new method of controlling machine tools.

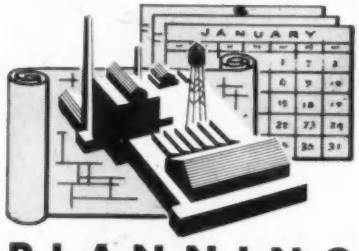
By this new method, numerical control automatically positions the machine tool cutter and guides it over the work in response to instructions in digital form recorded on film, paper, or magnetic tape. It is so new that there are only a few machines actually in full-scale use in the country.

When used on profiling machines in the aircraft industry, this method reduces the time between release of engineering drawings and start of production. The close-tolerance cam bars required to control conventional machines are not needed.

Also, machining operations are automatically controlled completely and independently along each axis of a machine. This advantage is especially marked in three-, four-, or five-axis machines. The machine can be programmed to perform completely automatically throughout a series of operations and thus increase productivity by eliminating down time for cam changing and decisions by the operator.

With numerical control the cutter is guided along its path in a series of straight line increments. Curves are approximated by breaking them into a number of straight line elements. The number of elements is so chosen that the maximum difference between an element of a curve and its chord is less than the allowable tolerance. In practice the minimum straight line increment is held to 0.0005 in.

Machining long, shallow, straight line tapers is approximated by a series of 0.0005 in. steps. The numerical control systems are error-driven through an electro-mechanical feed back loop. The system error can be made extremely small.



PLANNING *for* TOMORROW

Preparing the Tape

Proper tape preparation is the key to good numerical control. Present systems require first the computation of the numerical data. Then these data are transcribed into punched coded tape. This information is fed into a director-computer which converts it into machine-controlling pulses on magnetic tape. The magnetic tape is applied to the control equipment of the machine tool.

Future production programming will make use of numerical control of machine tools

I. L. Bertrand, Lockheed Aircraft Corp.

Based on secretary's report of panel on "Machining, Tracer and Profile" held at the SAE Golden Anniversary Aeronautic Production Forum, Los Angeles, Oct. 11, 1955.

Equipment used to prepare the magnetic tape is expensive. It would not be economical to purchase this equipment to service one or two machines in a plant since most of the time this equipment would stand idle. So, outside service companies are called in to prepare the tapes.

Initially, the cost of a particular development must be pro-rated over the first few machines. This is expensive. Also the cost of developing numerical controls of comparable complexity for a low priced and high priced machine are likely to be very close. That is one reason why large expensive machines will be numerically controlled first. Not only will the price be more in line with basic machine cost, but the increased productivity will be worth more. For example, $150,000 control of a $30,000 machine would require 500% increase in productivity to break even. However, a $150,000 control on a $300,000 machine requires only a 50% increase in productivity.

Cost will be a significant deterrent until industry gets some production experience which will justify numerical control economically.

(The report on which this article is based is available in full in multilith form together with reports of 15 other panel sessions held at the SAE Aeronautic Production Forum, Los Angeles, Oct. 11, 1955. This publication, SP-313 is available from SAE Special Publications Department. Price: $2.00 to members, $4.00 to nonmembers.)

THE PANEL

This article is based on the secretary's report of the discussion which took place during the Machining, Tracer and Profile Panel of the SAE Golden Anniversary Aeronautic Production Forum, Los Angeles, Oct. 11, 1955.

Panel Leaders

R. L. Hand, Lockheed Aircraft Corp.

A. E. Hill, Convair Division, General Dynamics Corp.

Secretary

I. L. Bertrand, Lockheed Aircraft Corp.

Members

O. A. Foss, North American Aviation, Inc.

D. G. Watt, Douglas Aircraft Company, Inc.

K. L. Wilson, North American Aviation, Inc.

Representatives of five top companies give tips on . . .

. . . Controlling

Scientific control of manufacturing costs aids the manufacturer in making a profit and enables the customer to receive a better product at lower cost. With expanding production requirements, cost control in the future will play an even greater part toward these ends.

Douglas Aircraft uses scatter diagrams—

N. H. Shappell, Manufacturing Control Manager, Douglas Aircraft Co., Inc.

The use of standards should be governed by their economic justification with the degree of refinement dependent upon the rate and volume of production. For example, standards for an item produced by the thousands each day would certainly justify detailed time study and perhaps micromotion study while nonrepetitive research or development work would immediately preclude any attempt to time study the operations.

Standards are generally established using either time study, standard data, methods time measurement, historical data, or work sampling. Any combination of these methods can be used dependent upon the area to be controlled and the type of manufacturing involved. Table 1 shows some of the standards used for various areas of control.

A common method of control in the sheet metal fabrication area is to establish cost centers around similar pieces of equipment. This method permits the use of average standards for setup and run time. The machine shop area is one where the high unit cost of the average machined part usually justifies time study of every operation.

The Assembly and Installation operations are areas where standards are usually economically justified. Here we use time study and methods time measurement standards set by experienced analysts who determine the effect of learning trends and establish through judgment the point at which the standard will be reached. Estimates of work in process are also used in these areas in reporting performance data.

The use of individual standards for tooling is comparatively expensive for this type of nonrepetitive work. The use of experienced analysts, standard data, and historical actuals for similar types of tools presents the best approach. Average standards can be used with nondesign tools which can be classified and on which volume is high.

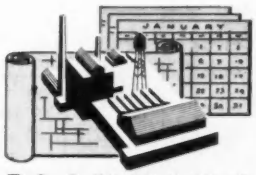
Research and development work can be controlled by using overall budgets which limit costs for a given project. Evaluation is made from progress or status reports. The budget, of course, would have flexibility to meet changing conditions.

The reporting of actual or variance from a standard should be brief and concise but meet the requirements for proper control. Generally, weekly reports are adequate but with advances in electronic data processing equipment daily reports may become economically justifiable and greatly increase the effectiveness of control.

The reporting of variance should tie into the lines of responsibility starting with the leadman and building up through the various levels of supervision. This simplifies the follow-up action necessary, but it cannot be made automatic. It must start from a realization by management that any cost system will fail without direct and positive corrective action on their part.

The first step in making a flexible budget for a particular **indirect function** is to determine that portion of direct labor that generates the need for the function. By using a scatter diagram (see Fig. 1) historical costs can be correlated and the indirect function related to the base direct function for any level. An indirect budget that requires that indirect costs fluctuate in the same historical manner can then be represented by drawing a line of best fit through the points on the "scatter" diagram.

The control technique used with this budgetary



Manufacturing Costs

M. E. Humphrey, Rohr Aircraft Corp.

Based on secretary's report of panel on Control of Manufacturing Costs held as part of the SAE Aircraft Production Forum, Los Angeles, Oct. 11, 1955. Panel leader was A. F. Kitchin, Rohr Aircraft Corp.; panel co-leader was N. H. Shappell.

approach is to keep statistical data for each major indirect service such as Inspection, Parts Supply, and Shop Supervision, in relation to direct labor departments. Fig. 2 plots the costs of various indirect services, as well as, indirect costs as a percent of direct labor costs and illustrates the use of statistical data.

When wide variances occur the function is reviewed by management who assign analysts to study the function for corrective action to keep the desired level of costs.

The foregoing approach is perhaps the simplest and most economical means of control but more effective control can be gained through the use of work measurement programs. Some progress has been made in this direction in various areas of control where operating standards have been established by time study. The reductions in cost that have followed the establishment of these programs indicates that additional opportunity exists for more comprehensive programs.

Other cost reduction measures used which contribute to the control of indirect costs include the suggestion system, conservation programs, good housekeeping, equipment utilization reports, and training programs.

Close control of direct costs is almost universal, but the same attention has not been applied to in-

Table 1—STANDARDS FOR COST CONTROL

	AREAS OF CONTROL	TYPES OF STANDARDS USED	UNIT OF MEASUREMENT
I	Fabrication a. Sheet Metal	Average Standard By Cost Center	Average Part
	b. Machined Parts	Time Study By Operation	Individual Part
II	Assembly and Installation	Standard Data and Time Reduction Curve	Equivalent Unit
III	Tooling	Standard Data, Estimates, and Average Standards	Individual Tool Average Tool
IV	Research Development Experimental	Budget	Project

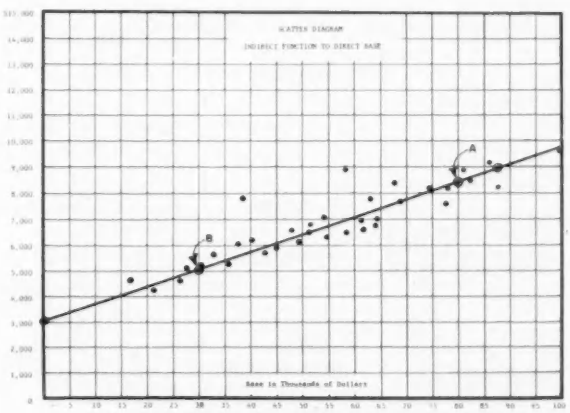


Fig. 1—The scatter diagram plots historical indirect costs against the direct costs generating the overhead. An indirect budget that requires indirect costs to fluctuate in the same historical manner is represented by drawing a line of best fit through the points on the scatter diagram.

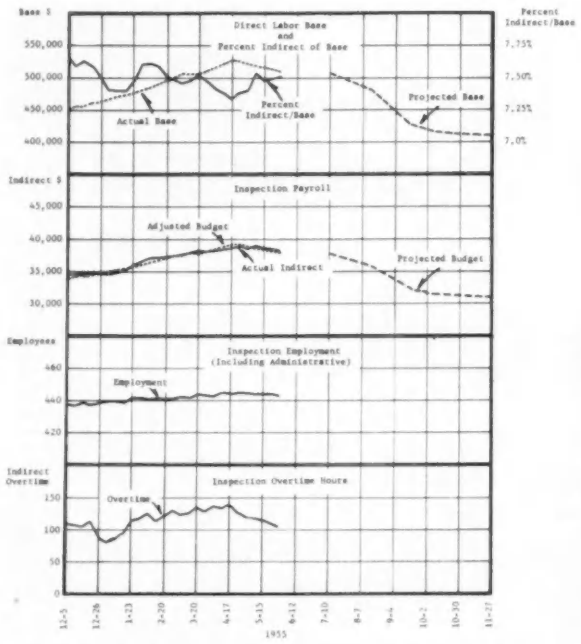


Fig. 2—Various indirect inspection costs and percent indirect to direct labor costs are plotted using fabrication direct labor costs as a base.

direct costs. The approach to this problem should be the same as to direct—determine the objective, establish a target, report the variance and provide for follow-up action.

Boeing Airplane uses budget formulas–

J. W. Barton, Budget Control,
Boeing Airplane Co.

Interpretation of the term "standard" in a broad sense is any predetermined allowance for doing a specific task. At Boeing much progress has been made in the area of control by standards. (See Table 2).

Engineering is controlled by two types of standards. Estimated standards—an allowance for a given task based on familiarity with the required work, and statistical standards—developed from historical data. Project group engineers at Boeing establish estimates for each item of work and actuals are then posted daily. The physical percentage of completion is estimated and compared on each item and in total on a weekly basis. Standards for developmental work are also on an estimated basis with actual costs versus standard costs, reported on a monthly basis.

In tool design both estimated and statistical

Table 2—DIRECT LABOR COST CONTROL BY USE OF STANDARDS

DIRECT LABOR CATEGORY (% of Total Direct Labor)*	TYPE OF STANDARD	FINENESS	VARIANCE REPORTING	
			Frequency	Organization Level
Engineering (8½%)	Estimated	Each Project Item and Component	Daily	Group Engineer and Leadman
			Weekly	Project Engineer and Chief Engineer
			Monthly	Top Management—P.C.R.
	Statistical	Staff Group and Major Item	Weekly	Unit Heads—Chief Tech. Staff
			Monthly	Chief Engineer—Top Management
Developmental (1%)	Estimated	Item	Monthly	Foremen—Top Management
Tool Design (1½%)	Estimated	Each Major Tool	Bi-Weekly	Tool Design Supervision—Operations Manager
	Statistical	Average by Type of Tool		
Tool Fabrication (7½%)	Estimated	Each Design Tool (15% of Tools 70% of Labor)	Daily	Immediate Supervisor
			Weekly	All Tooling Supervision
			Monthly	Tool Superintendent & Top Management
	Statistical	Average by Tool Type for Tools under 50 Hours	Monthly	Tool Superintendent & Top Management
Production Labor Fabrication & Minor Assembly (39½%)	Statistical	By Classification, by Lot Number	Monthly	General Foremen—Top Management
	Standard Data	Individual Part and Workman (50% Coverage—Sept. 1955)	Daily	Immediate Supervisor
			Weekly	Shop Supervision—Shop Superintendent
			Monthly	Top Management
Major and Final Assembly	Method Study	Supervisor's Task, By Unit Number	Daily	Immediate Supervisor
			Weekly	Immediate Supervisor—Operations Mgr.
			Monthly	Top Management
	Statistical	Airplane Section—By Unit Number	Monthly	Foremen—Top Management

* Based on 600 Transport Airplanes

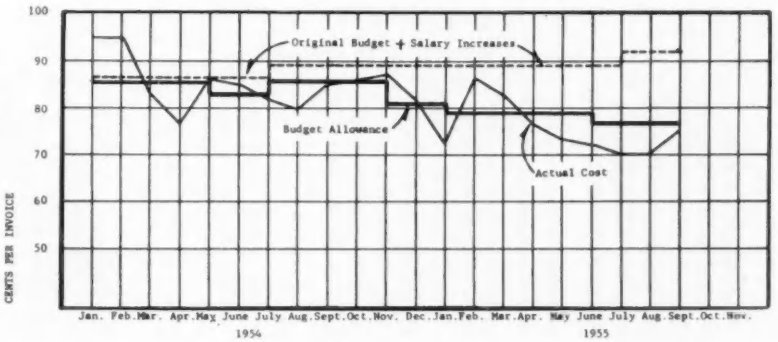


Fig. 3—Invoices processed provide a good measurement of salary and wage expense for an Accounts Payable Department in a typical budget formula based on work output.

standards are used. Estimated standards for large design tools are set by tool estimators with the designer. For all other design tools historical standards are used. Actual versus standard is reported every two weeks.

Tool fabrication uses estimated standards for each designed tool. Variance reporting is done on a daily basis with weekly summaries provided to supervision. For non-design tools historical averages are developed and applied to completed tools. Monthly reports of standard and actual are provided.

The fabrication and minor assembly portion of production labor is covered by statistical standards for each lot or classification of parts. Monthly reports of actual versus standards are made for supervision. "Standard Data" standards are also used in this area. These standards are developed from tables and time studies of elemental operations. For Major and Final Assembly areas, standards are set by method study and statistics with daily, weekly, and monthly reports provided to various levels of supervision.

The action steps taken are the same in all cases. First, the task must be determined, then a standard established. Next the actual versus standard performance must be reported by echelon of management and reasons for variance established. Lastly, it is up to management to take action to either remove the reasons for adverse variances or to revise plans accordingly.

The organization for budgeting at Boeing consists of a top management budget committee, a budget staff group reporting to the corporate controller and various individuals in each department that have been assigned budget responsibilities. Detail budget formulas are established to relate **overhead expense** to some meaningful variable such as work output, or direct labor. Other budgets are determined primarily by executive or policy direction.

After the formulas are set by supervision and the staff group, these formulas become the basis for computing the budget allowance each month. Monthly budget versus actual reports are prepared.

An example of a typical budget formula based on work output is shown in Fig. 3. In this case invoices processed were found to be a good measurement of the Accounts Payable Departments' salary and wage expense. This same formula approach can also be used for costs other than indirect salaries and wages.

Budgets alone, do not form a very satisfactory tool for cost reduction as they are chiefly intended as a control device. Control coming from the action taken in reply to reported budget deviation. Cost reduction is achieved only by changing the methods or procedures for doing a task or by eliminating tasks. Budgets, when well operated, have a strong effect in increasing cost consciousness of an organization. Management motivates the action taken by creating a strong force or atmosphere targeted toward cost reduction.

Some other cost reduction methods used are incentive compensation, incentive type contracts, suggestion systems, and educational programs. It is felt that the strongest force of all, however, is the repeated pronouncement by top management that cost reduction is a primary goal and weights heavily in their decisions.

North American—departmental performance rating—

J. P. Anderson,

Manufacturing Superintendent,
North American Aviation, Inc.

The start of a new program is the point at which proper control should originate. To do this, project meetings are held periodically from the very early stages of engineering throughout the life of the contract. The initial meetings are attended by management personnel from engineering, planning, tooling and production. As a result of these meetings decisions are made that help to avoid designs that are difficult to produce economically at the required rates. As the program progresses and reaches the shop level, very close liasion is kept with engineering through the standards group. Progress meetings are held regularly in order to check progress and to point out areas in which designs are uneconomical from the tooling, planning, or production standpoint.

As production progresses, standard and actual costs are reported and variances established from which corrective action is taken. In addition to the usual standard and variance reports, North American uses a Departmental Performance Rating Program. This program rates the departments on nine factors (see Fig. 4) one of which is direct labor. As shown in Fig. 4, direct labor accounts for 39 points

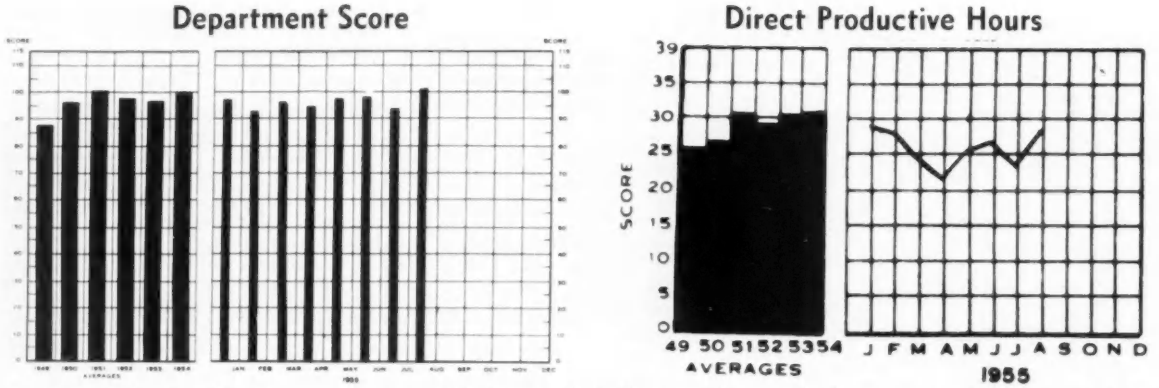


Fig. 4—North American Aircraft uses a Departmental Performance Rating Program which rates the departments on nine factors one of which is direct labor. This program is used for controlling direct and indirect costs.

of a possible perfect score of 115. This rating is on a monthly basis and the reports are published in the company paper. Incentive rewards for best score on a monthly and yearly basis are also used.

North American has decentralized many **indirect operations** to establish undivided responsibility within a given area or department. Indirect operations decentralized are:

Production Control
Departmental Tool Cribs
Shop Clerical
Janitorial Services
Engineering and Shop Liaison
Material Conservation
Crane and Lift Operators
Nonproductive Material Control

By decentralizing these services and making them the responsibility of the foreman, it is felt that a more economical ratio of indirect costs to direct can be obtained. This also brings to the attention of the foreman operations contributory to his performance over which he would not ordinarily have control, such as, the preparation of budgets, supervision of indirect operations, and the control and ordering of nonproductive supplies. He also shares in the responsibility of developing procedures, such as for production control, and in developing factors for budgeting and measuring performance. Performance is measured in relation to hours earned with nonproductive supply costs related to historical data.

The departmental performance rating program, Fig. 4, is also used in controlling **indirect costs.** The factors rated in addition to direct labor are:

Schedule Position	20 points
Production Control	13 points
Rework	10 points
Supporting Personnel	13 points
Lost Time	5 points
Safety	5 points
Housekeeping	5 points
Nonproductive Materials	5 points
Direct Hours	39 points
Total	115 points

The results obtained from this decentralization of indirect operations are a more economical ratio of indirect to direct, undivided responsibility, and control of costs at their source.

Lockheed Aircraft considers learning progress—

T. R. May, Manager, Budgets and Forecasts, Lockheed Aircraft Corp.

Standards can be defined as the time that a skilled worker should take to complete a job with which he is familiar, using material, tools, and facilities as formally planned. Standards should be applied to all repetitive fabrication and assembly work and to nonrepetitive work wherever justified. The development of fabrication standards can be fixed by formula techniques. Assembly standards can be first estimated then later revised, based on time or some other type of study.

Standards can be used in the development of departmental direct labor budgets, for short range shop loading, as a cost accounting device for distribution of fabrication labor, for measuring individual worker performance, as aids in establishing prices, and for determining the degree of completion for budget purposes.

Reporting against standard can be done in many ways, using either pure standards or some type of adjusted standard which reflects an intermediate degree of learning progress. Lockheed reports against allocated hours that represent standard hours plus a fair adjustment for work conditions and learning progress. (See Fig. 5).

Control of Planning, Tool Design, Tooling, and Manufacturing is done by airplane segment. The establishment of the segments being a joint effort by engineering and manufacturing preplanners. Control by segment brings together parcels of common work from the first stage of engineering to delivery. For example, records of engineering releases, engineering effort, and degree of completion are re-

ported actual versus schedule. This follows through the various stages of tool design, fabrication and production. Areas of variance can be detected immediately by segment, thus permitting corrective action to specific parcels rather than broad areas.

Performance reporting is generally done on a weekly basis with informal daily reports where necessary. Reports are made to line supervision who can call upon budgeting, manufacturing and time study engineers to assist him to excel in cost control.

Direct effort can be measured and controlled by use of a common denominator—time standards. There apparently is no common denominator for budgeting **indirect effort** despite the fact that indirect effort is generally expressed as a percent of direct labor or some similar means. Therefore, complete series of different applicable denominators or indexes should be used for indirect labor budgeting.

Fig. 6 shows an indirect budget drawn on the same basis as the direct budget using a standard as an index. This chart shows a parallel between control of direct labor by time standards and control of indirect labor by a standard.

Obviously, any index would have to meet several tests as follows:

1. Must be realistic and sensitive.
2. Must have been and be readily available.
3. Must be understandable and saleable.

Controlling indirect labor costs can be done in different ways—by the use of "head" counts or with the primary emphasis on dollars. The latter method appears to be more desirable when sufficient historical data is available, but the head count is easily understood and is very effective during start up periods of new facilities.

Annual budgets on all elements of controllable costs are used at Lockheed. These budgets are presented to management for approval as an overall operating plan. From this annual budget, quarterly budgets are negotiated in weekly detail for control reporting with all levels of management participating.

Use of the budget in itself, as a cost reduction tool, is not feasible as the budget is only a plan. Effective use of the plan and prompt follow-up by management to correct unbalanced conditions is the means through which control and cost reduction is achieved.

Detail budgets for indirect expenses, other than indirect labor and directly related accounts, can be established if the dollar amount is sufficiently large so that control costs would be economically feasible.

McKinsey & Co.–the nonfunctional approach–

P. J. Koen, Associate,
McKinsey and Co., Management Consultants.

Good "yardsticks" are essential to do a better job in such things as forecasting manpower, leveling work loads, developing schedules, fully utilizing men and machines, and controlling costs. However, this is not the whole answer to building better airplanes cheaper.

One other significant factor in the cost of an airplane is the inherent basic cost designed into the product. An adequate cost system can not overcome this problem as these basic costs are extremely difficult to ferret out. These costs are somewhat related to the manner in which the aircraft industries have organized and operated and the fact that the aircraft industry is different.

First, it is different in that it operates on the outer fringe of technological development and is a dynamic industry characterized at every moment by change. Second, designing, planning, tooling, and productive phases all go forward in full swing simultaneously. The third difference is complexity of the product and critical relation of its pieces, and fourthly, as a result of complexity and the other differences, many varied skills in many different fields are vital to the successful completion of a program.

The approach followed by the industry has been to

CONTINUED ON PAGE 69

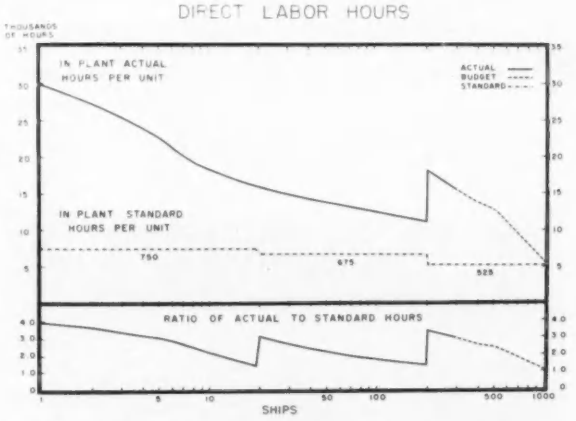


Fig. 5—Lockheed reports against allocated hours that represent standard hours plus an equitable adjustment for work conditions and learning progress.

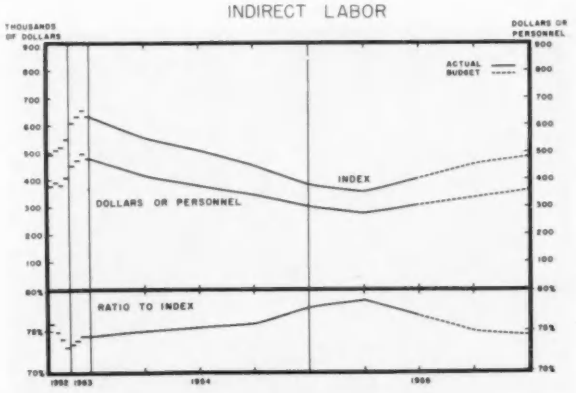


Fig. 6—An indirect budget drawn up on the same basis as the direct budget, that is, using a standard as an index. This chart shows a parallel between control of direct labor by time standards and control of indirect labor by a standard.

W. Crofut and L. B. Keller, Plastics Department, Hughes Aircraft Co.

Based on paper "High-Quality Plastics Components for Use in Guided Missile and Airborne Radar Systems" presented at SAE Golden Anniversary Aeronautic Meeting, Los Angeles, Oct. 14, 1955.

Processing Makes

UNLIKE most other materials for engineering use, plastics must undergo a radical conversion in the fabrication process. Because of the rapidity of the initial reaction, the conversion appears to be made by purely physical means at elevated temperatures.

Actually, a complex system of chemical and physical changes takes place throughout the molding cycle which may last for the extended cure time. Parts of identical shape and made from the same raw material may range from excellent to worthless depending on the care and precision used in the conversion or fabrication stage.

Following are typical examples of the problems associated with the manufacture of plastic components and serve to emphasize the effect of processing conditions on the properties of the finished part. Each of these processes has been, or is being, applied successfully at Hughes Aircraft Co.

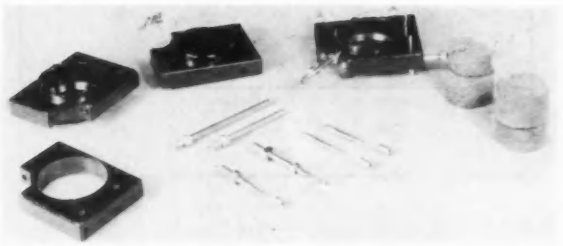


Fig. 1—Molded clamp showing from right to left, preformed molding material, molded part with inserts, bottom and top views after removal of inserts, and finished part.

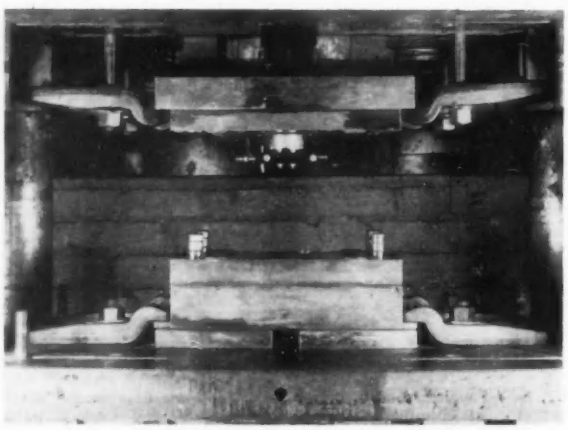


Fig. 2—The clamp mold with the part shown in the ejected position.

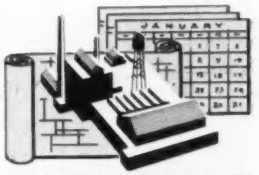
1. Transfer-Molded Radar Clamp–

This part was formerly machined from a solid block of phenolic paper-based laminate, a process which involved 25 separate machining operations. The clamp, which serves both as a mounting bracket and as an electrical insulator, contains four threaded holes and two small holes having an exceptionally large length to diameter ratio.

It was necessary that a molding material be selected that would give the part adequate toughness and some flexibility. Sample clamps were made from several different molding materials and were physically tested. Usually, parts made from a glass filled material are stronger than those made from other plastic materials. Here, however, a thin section in the part did not permit the long glass fibers to orient well.

None of the molded sample clamps were as strong as the original machined laminate. However, the nylon phenolic parts were the strongest of those molded and had adequate strength for use in this part. The conversion was made from a machining to a molding process (see Fig. 1), and the mold was designed for use with the nylon-fiber-filled phenolic material (see Fig. 2).

All holes and threads are now molded in, and the only machining operations required are those for the removal of flash and the milling of one slot. Also, since the material of the molded part is fungus-inert, the fungus resisting lacquer treatment formerly applied to the machined parts can now be eliminated. Molding of the parts under various con-



the Plastic

Here are 7 processes which are making high-quality plastic components at lower cost.

ditions, each of which was carefully controlled, revealed that the strength of the nylon phenolic part was reduced by high cure temperatures.

It was also found that extended cure times affected the strength of the clamp. The optimum curing conditions (285 F for 6 min) were specified for fabrication. This assured uniformly strong clamps at about one-fourth the cost of the machined parts.

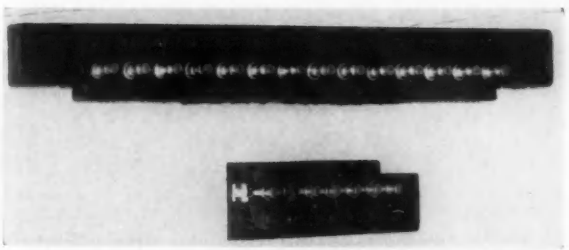


Fig. 3—A terminal board and a sectioned part revealing slight porosity.

2. Compression-Molded Terminal Board—

This part, shown in Fig. 3, is typical of innumerable electrical parts used in airborne radar systems. It was formerly machined from paper-base laminates with inserted terminals. Conversion was made to a compression molding using standard mineral-filled phenolic material. From previous experience, this material was considered adequate; however, the first molded parts did not retain sufficient d-c resistivity after exposure to humidity.

An investigation was undertaken to determine the effect of molding conditions on the electrical and physical properties of the terminal boards. It was determined that the d-c resistivity of the part, both before and after humidity cycling was much increased by drying the material at temperatures of 140 F to 160 F before molding.

The range of cure temperatures and cure times for best electrical characteristics was also determined. It was found that conditions which increased the d-c resistivity of the part also increased the ultimate breaking load in flexure. The poor electrical qualities that were found in the first molded parts were eliminated from later parts by specifying that the material be predried and that a sufficiently long cure within the optimum temperature range be used.

3. Injection-Molded Part—

An insert core lock (see Fig. 4) is another example of conversion from a machining to a molding process. The function of this part is to lock tiny cores in exact position in wire-wound coils. An exact thread was required over the full length of the part; close tolerances were also required on other dimensions.

Attempts were made to machine these parts on

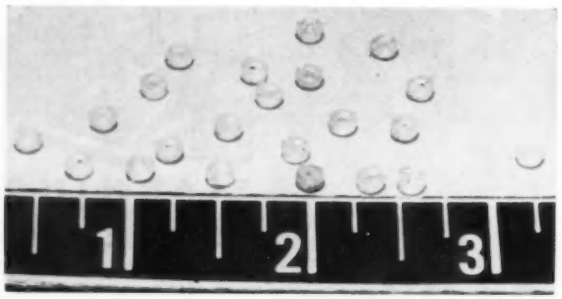


Fig. 4—Molded insert core lock parts with their size indicated by the inch rule.

Fig. 5—This antenna lens assembly consists of a group of injection-molded lens-shaped parts which are made of titanium dioxide loaded styrene.

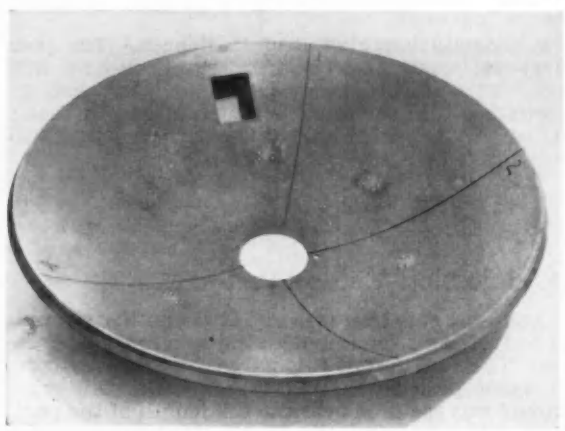


Fig. 6—This antenna reflector has a parabolic contour that is more than 20 in. in diameter. The part incorporates a metallic layer that acts as the radar reflector.

automatic screw machines, using a variety of plastic materials. It was very hard to machine the parts to the required dimensions and the rejection rate was very high. An injection mold was developed that incorporated an automatic unscrewing mechanism to form the fully threaded cavity and to eject the parts. The injection-molded parts were within print tolerances and rejection rates were very low.

4. Injection-Molding Using a Specially Formulated Material—

The antenna lens assembly shown in Fig. 5 consists of a group of injection-molded lens-shaped parts, which are made of a specially formulated thermoplastic material and which are fabricated to close tolerances. A high dielectric constant was obtained in the material by the dispersion of finely divided titanium dioxide pigment (up to 68% by weight) in a commercial polystyrene material. No major difficulties were encountered in fabricating the parts, but localized burning and charring sometimes occurred in service.

X-rays of finished parts indicated that aggregations of titanium dioxide particles occasionally occurred which were large enough to cause overheating during the passage of high frequency energy. The titanium dioxide was dispersed in the styrene by grinding the two materials together and then extruding the mixture in a conventional extruder.

This procedure, although repeated several times, did not properly disperse the titanium dioxide. Investigations were made of other methods of mixing, with the result that a single milling operation on a two-roll mill was found satisfactory. The cost of the material was reduced by use of this milling process; all parts made from this material were satisfactory.

5. Low Pressure Reinforced Laminated Part—

The antenna reflector shown in Fig. 6 has a parabolic contour and is more than 20 in. in diameter. The dimensional, physical, and electrical requirements for this part are severe. The concave surface of the reflector must conform to the true parabolic surface of revolution within ± 0.10 in. In operation, the part is subjected to abrupt changes in humidity and temperature, during which the contour must never deviate more than 0.015 in. total from its original shape.

The part must also be rigid and keep its essential shape under severe vibration. The part incorporates a metallic inner layer that acts as a radar reflector. This layer must be continuous and its resistance must not fall below a given value. All these requirements were to be met by a part that was maintained within critical weight limitations. The parts were

layed up from three layers of glass cloth with liquid polyester resin; one layer of glass cloth had been metallic coated.

Molding was done in heated matched metal tooling. The reflectors, as first made, were acceptable except for a tendency to warp after exposure to humidity. An investigation of the process and testing of parts revealed that acceptable reflectors could be made by using an extended cure in the mold.

The investigation also disclosed the extreme care that was necessary in all phases of the process, including preparation of the material, lay up, cure cycle, and postmolding handling. All this information was compiled in a process specification. In the subsequent production of these parts, the rejection rate has been very low.

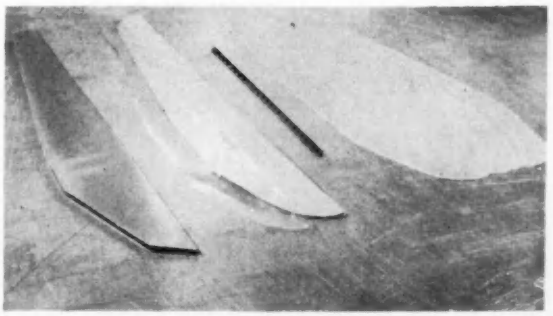


Fig. 7—The stabilizer glove layup process showing from right to left the cut plies, metallic attachment, finished layup, and the molded part.

6. High-Pressure Molded Laminates—

The stabilizer glove shown in Fig. 7 is subjected in operation to rapid aerodynamic heating to temperatures as high as 500 F. The part must withstand flutter and severe loads in flight at supersonic speeds. It must also have an aerodynamically clean surface and the thickness throughout must be held to 0.040 ± 0.003 in.

Some of these parts incorporate a metallic insert. To decrease moisture absorption and so reduce the probability of delamination under rapid heating, an essentially void-free laminate is required. The material selected was a high-temperature phenolic plastic.

The preimpregnated glass cloth used in the manufacture of these parts is controlled by the impregnator to have a narrow range of resin content, volatile content, and greenness (degree of resin advancement, or cure). The cloth is cut into plies as shown in Fig. 8 and stacked in a preform. The metallic edge attachment is put in place and the preform is warmed and bent into shape for insertion in the mold. The finished preform may be oven dried at 140 F to 160 F just prior to molding, if this is necessary to eliminate volatiles and to advance the resin so that it has the correct viscosity in the molding operation.

When ready for molding, the preform is centered on the punch of a hardened steel mold (see Fig. 9). The hot mold ($300 \text{ F} \pm 5 \text{ F}$) is closed rapidly until the upper cavity just contacts the preform without exerting pressure. This distance is maintained for a precise number of seconds (usually between 15 and 25 sec) to permit the escape of volatile materials and to preheat the resin to the proper consistency for flow in the mold.

The mold is then closed to fixed lands under pressure (2000 psi based on projected area). In the final closing of the mold, pinchoffs in the punch and cavity restrict the flow of resin; this allows high pressure to be exerted on the layup. A small percentage of resin (5 to 10% by weight) is eliminated from the molding during the molding operation. After curing in the mold for the comparatively short time of 8 to 12 min, the molded part is removed from the punch (see Fig. 10).

The molded parts are postcured in a circulating-

Fig. 8—Cutting the preimpregnated cloth for stabilizer glove layup.

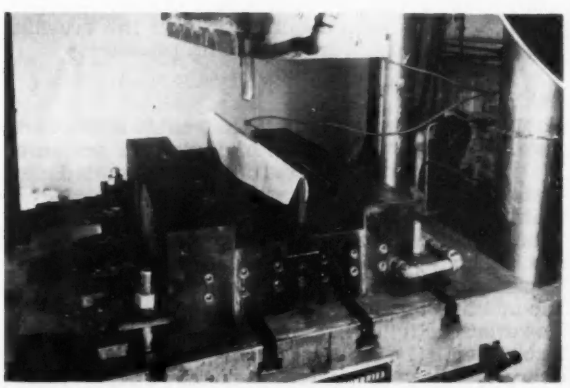


Fig. 9—The stabilizer glove mold with preform in position.

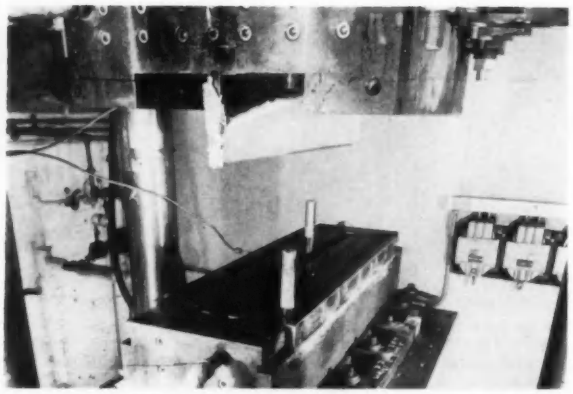


Fig. 10—The stabilizer glove mold and molded part after subjecting the part to 2000 psi based on the projected area.

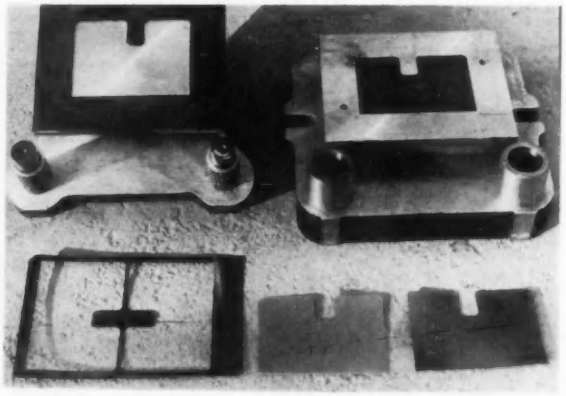


Fig. 11—An example of a blanked structural panel together with the die used to produce it. Panels of this type can be produced within tolerances of 0.002 in. over dimensions of several inches.

air oven in which the temperature is slowly raised to approximately 400 F over a period of several hours. The parts are then trimmed, inspected, and bonded to the stabilizer frame. This process produces uniform parts meeting very rigorous requirements.

7. Application of Metal Fabrication Techniques to Produce Missile Parts—

The high-temperature phenolic glass laminates previously described have such excellent physical characteristics at elevated temperatures that they are frequently used as load-bearing panels in stressed-skin constructions. Because the panels are flat, they can be blanked within very fine tolerances from thin (0.030 to 0.100 in.) premolded laminates.

An example of a blanked structural panel is shown in Fig. 11 together with the die used to produce it. Panels of this type can be produced within tolerances of ± 0.002 in. over dimensions of several inches. Conventional flat-ground punches and dies mounted in standard metal-stamping presses are used. Positive-acting stripper plates are mounted on both punch and die and the stripper plates are faced with die rubber. These precautions prevent delamination at the cut edge or damage to the laminate by impact.

The foregoing examples show the wide variety of uses to which plastics can be adapted in missile and radar systems. Most of the specific applications described are unusual only because of the degree of process control and the uniformity obtained.

For complete paper (in multilith form) on which this abridgment is based, write SAE Special Publications. Price: 35¢ to members, 60¢ to nonmembers.

Discussion

Mr. Sink— Zenith Plastics

Have you experienced difficulty with the crushing of glass when using high molding pressures?

Authors—

We have experienced very little trouble with crushing of the glass fibres from high molding pressures. We place a known thickness of preimpregnated glass cloth in the mold, and the mold closes to lands providing a fixed clearance between punch and cavity volume. Furthermore, fairly highly advanced resins are used, and pressure is applied slowly. The high viscosity resin seems to support the glass fibre during the molding operation and crushing does not occur. However, the following may cause the glass fibres to be crushed. (1) Wrinkles in the preform. (2) Resin above or below the correct viscosity range. (3) Incorrect closing of the mold. (4) Glass cloth which does not meet specifications. Some production parts at Hughes are molded at 20,000 psi.

Mr. D. Spoon— Lockheed Aircraft Co.

Does Hughes rely solely on process control to assure high quality, or are there regular inspection procedures?

Authors—

Process control is supplemented with standard inspection procedures. Receiving inspection on laminating materials includes testing every roll for resin content, volatile content, flow, and greenness All laminated parts are visually and dimensionally inspected. After molding, specimens from the trim area of stabilizers and similar parts are tested for flexural strength and modulus at operating temperature (400 F to 500 F according to use). Radomes

are subjected to electrical tests, and a certain percentage subjected to a burst test from external pressure at operating temperature. Qualification testing may include resin content, water absorption, load deflection tests, and many others.

Mr. F. Karas—Mesa Plastics

Which of the 500 F to 600 F materials would compare favorably in electrical properties to DAP-Orlon filled molding material?

Authors—

We have only three materials which could be called suitable for this range: glass filled Phenolic; glass filled Triallyl Cyanurate Polyester; glass filled Silicone. When measured in the dry state, all of the materials would compare favorably with DAP-Orlon in insulation resistance, and the silicone would be superior to DAP-Orlon in loss characteristics. However, after exposure to humidity, all of the high temperature materials would suffer a severe drop in insulation resistance, while the DAP-Orlon would be practically unaffected. Also, the DAP-Orlon is not seriously affected by soldering operation on molded-in terminals. I do not know of any electrical measurements which have been made on the high temperature materials at 500 F to 600 F.

Mr. H. Frazier— Aerophysics, Development Laboratory

Have you had any experience with the use of asbestos fillers in laminates?

Authors—

We are investigating asbestos reinforced laminates at this time. There are indications that asbestos filled laminates may be superior to glass fillers in their resistance to delamination and blistering under sudden heating.

Mr. G. N. Mangurian— Northrop Aircraft, Inc.

Is there any possibility that the strength of glass fibres will be increased so that reinforced plastics will become competitive with metals?

Authors—

I would like to answer the last part of your question first. I believe that plastics are already competitive with metals in many applications. For instance, in the stabilizer skin described in the paper, we have no other material which will give us sufficient strength and rigidity at 500 F for equal weight. Aluminum and magnesium would be impractical at this temperature. Titanium could be used with a weight penalty, but this would probably be more expensive in material and fabrication costs than the reinforced plastic. Now with regard to the strength of glass fibres, I do not think that their intrinsic strength can be increased significantly. Improvements will come in the prevention of the degradation of this strength during processing and weaving, by superior washing, sizing, and finishing treatments. Also significant advances may come from work now in progress on quartz, aluminum oxide, and titanium dioxide fibres.

Controlling Manufacturing Costs

Continued from page 63

segregate these skills organizationally by function—setting goals or targets for each function. As a result purpose, effort, and attention is concentrated within the functional organization limits and is dependent beyond these limits upon coordination and interdepartmental procedures, sometimes at the expense of effective cooperative effort.

Perhaps a nonfunctional approach would help ferret out the product improvements known to foreman and shop people. A nonfunctional approach to organization that would establish common product goals for designers, planners, tooling, and shop personnel for a small unit of the airplane such as wings or fuselage. This group would work as a team with the achievement of standard being a team responsibility, having cooperative goals for all the skills to work toward—not individually, but as a group, wherein the free interchange of ideas would be easy.

All budgets have one thing in common—they are all plans reduced to dollars and cents. Control means following these plans. The plan itself may be a good budget or it may be a poor one. The things that make the difference in budgeting are objectives, flexibility and management.

The objective should be tied in with the objectives of all other areas of organization. They should be such that they can be explained to subordinates who must work and live with them. The average person wants intelligent direction and wants to feel that he belongs to the overall organization. The human aspects of budgeting should not be overlooked.

The budget must be flexible. It must be able to meet changing conditions, especially in the aircraft industry where schedule changes are constantly occurring. It must show what costs should be at various levels of activity in the cycle of the design and production of an airplane. Flexibility can be achieved by cooperative effort, where those responsible for executing the plans play a part in making them.

The third thing that makes the difference is management. Not management particularly but the relationship that exists between the various levels of management that have the responsibility of living within the budget or plan. Within the management category are a number of other important things such as clear cut organizational lines and proper methods of selecting and training personnel.

The budget itself is not a cost reduction tool but developed along these lines, better co-operation will be achieved along with reduced operating expense.

(The report on which this article is based is available in full in multilith form together with reports of the fourteen other panel sessions of the 1955 SAE Aircraft Production Forum. This publication, SP-313 can be obtained from SAE Special Publications Department. Price: $2.00 to members, $4.00 to nonmembers.)

Production Predictions

Landing gear will be built for a long time to come. Conventional types will serve most aircraft, even after vertical take-off and landing equipment is perfected for certain fighters. And even VTOL craft will need some kind of shock-absorbing gear.

Fighter wings are already too thin to accommodate landing gear. Since flight speeds can be counted on to go higher and higher, and wings, therefore, to get thinner and thinner, no change in landing gear location is likely for fighters. Landing gear makers can expect to go on building fuselage-type gear—with more and more complicated folding arrangements.

Future bombers and transports will probably have wings thick enough to take the landing gear. Loads may have to be distributed over 8 to 16 tires, on bicycle or even unicycle gear.

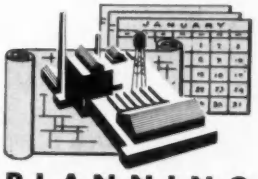
Manufacturers of landing gear can count on working with harder, stronger steels in the future. Already AMS 6418 and AMS 6427 steels heat-treated to 220,000–240,000 psi tensile strength are in the picture. It won't be long until 280,000 psi is demanded. Even 350,000 psi isn't impossible. (SAE 4340 used at the start of World War II was heat-treated to 180,000–200,000 psi.)

In the high-strength heat-treat ranges, ductility is poor and often hydrogen embrittlement shows up during cathodic pickling or electroplating.

Shock struts fabricated almost completely of 75ST aluminum have proved very successful. Strut diameter is larger with aluminum than with steel, but in designs where the space is available, aluminum saves weight. An increasing number of designs call for struts with outer cylinders of aluminum alloy and inner cylinders of steel heat-treated to high strength. Also, landing gear manufacturers are experimenting with making some strut parts of titanium.

Hydraulic controls manufacturers will get the business of making shimmy dampers, steering systems, and actuators for retraction systems. In these applications, hydraulic systems have replaced electrical systems because the former are lighter, cheaper, and give greater design flexibility.

Levered suspension gears used in the new Lockheed F-104 and the North American FJ-4 will be watched with interest by landing gear designers and manufacturers. If they show advantages, they may appear in future American designs. They have been used widely by European designers, but for previous American designs, they would have incurred a landing gear weight increase of 10–20%.



PLANNING *for* TOMORROW

on Landing Gear

F. M. Rayburn, Manager, Tool Control Department, Menasco Mfg. Co.

Based on secretary's report of panel on Landing Gear held as part of SAE Aircraft Production Forum, Los Angeles, Oct. 12, 1955.

More anti-skid systems will be produced. Devices which sense an incipient skid and automatically release the brake are becoming a necessity. They are the only way to secure maximum effective deceleration and to protect against flat spots and blown tires. They often double tire life.

Machine tool makers will find landing gear manufacturers good customers for their sturdiest products. It takes heavy, generously powered machines to cut the tough steels that go into landing gear. Few special purpose tools are required. Production runs are too small to justify them. But the variety of operations performed calls for many standard types: horizontal and vertical boring mills, engine lathes, turret lathes, radial drills, vertical and horizontal mills, thread mills, and internal and external grinders and hones. Also used are extensive facilities for heat-treating, welding, chromium plating, cadmium plating, anodic treating, and shotpeening.

SERVING on the panel which developed the information in the accompanying article were . . .

F. G. Fenger, panel leader
Menasco Mfg. Co.

J. E. Gerry, panel co-leader
Menasco Mfg. Co.

F. M. Rayburn, panel secretary
Menasco Mfg. Co.

P. Bukoff
Bendix Aviation Corp.

K. S. Carter
Lockheed Aircraft Corp.

P. S. Kikeli
The Cleveland Pneumatic Tool Co.

E. L. Martin
North American Aviation, Inc.

F. H. McLaughlin
Convair Division, General Dynamics Corp.

A. C. Gunsaulus
Goodyear Aircraft Corp.

R. M. Recktenwald
Menasco Mfg. Co.

C. R. Weaver
The B. F. Goodrich Co.

The report on which this article is based is available in full in multilith form together with reports of the 14 other panel sessions of the 1955 SAE Aircraft Production Forum. This publication, SP-313, can be obtained from SAE Special Publications Department. Price: $2 to members, $4 to non-members.

WILLIAM B. STOUT, President of the SAE in 1935, died suddenly on March 20, 1956, of a heart attack. He had been ill a few weeks previously but had apparently recovered enough to resume nearly normal activity and was considered to be on the road to his usual good health when he was stricken.

Known to thousands throughout many countries of the world as Bill Stout, he had endeared himself to those who came in contact with him by his ready wit, his vast knowledge of multitudinous subjects, and his unique approach in the discussion of technical problems. A master of the controversial quip, the possessor of an easy facility with the Swedish dialect learned during his many years in Minnesota, and a fund of stories to go with it, he was in great demand as an after-dinner speaker and toastmaster. As such, he addressed groups in all fields of endeavor on a great variety of subjects from economics to engineering, the latter being his great love. He became an SAE member on Jan. 21, 1914.

Starting his long period of SAE activity as secretary of the Detroit Section in 1917, he served as vice-president of the Society in 1929 and again in 1932, both times representing aviation. For many years, before and after, he served on various SAE committees, presided at dinners and technical sessions, and presented many valuable technical papers before Society meetings.

Bill Stout's contributions to industry were not limited to the aircraft for which he is probably best known. His versatility produced toys, magazine articles, illustrations, newspaper columns, motorcycles, cycle cars, automobiles, buses, streamlined articulated railroad trains, and folding house-trailers. He was equally accomplished as an editor and reporter, an illustrator, an inventor, a designer, and an engineer.

His creative career in the automobile industry began in 1910, when, as chief engineer for the Schurmeier Motor Car Co. of St. Paul, Minn., he designed two motorcycles. During the same period, he was an editor for *Motor Age* and *Commercial Vehicle*, two leading automotive publications of the day. He also wrote special articles for the *Chicago Tribune*.

He later designed the "IMP" cyclecar for the McIntyre Motor Car Co. and in 1915 moved to Detroit as chief engineer of Scripps-Booth Co.

His entry into the aeronautic industry took place in 1916 when he became consulting engineer for the aircraft division of the Packard Motor Car Co. In 1918, his reputation caused him to be installed as technical adviser to the Aircraft Board in Washington and this was followed by a short period with the United Aircraft Engineering Corp.

In succeeding years, he founded the Stout Metal Airplane Co., and built the first American all-metal airplane which was constructed for the Navy. From this grew the famous Stout all-metal thick-wing monoplane which was later sold to Henry Ford. Shortly thereafter, the Stout-designed Ford tri-motored passenger transport plane was produced and it established a world-wide reputation. It was during this period that he formed Stout Airlines, which was the world's first commercial passenger airline and which was later taken over by United Airlines.

His designs of the thick-wing monoplane, the bat-wing plane, the rear-engine driven Scarab car, and the folding house-trailer were all well in advance of their times and many features of these vehicles have found their way into present design and production.

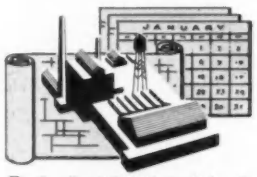
Since his retirement several years ago from formal business activity, he has made his home in Phoenix, Ariz., where he continued his beloved research into the mysteries of insect flight. He fully expected and intended to transform this research into a practical aircraft propelled by flapping wings. And, knowing his success with other seemingly impossible projects, his intimates had no doubts of his ultimate success in this venture.

Stout was born in Quincy, Ill., in 1880, the son of an itinerant Methodist minister. He was the survivor of twins, his twin sister dying shortly after birth. He had two other sisters, one of whom survives him.

His education was acquired in Hamline University and in the University of Minnesota. He was married in 1906 to Alma Raymond of Kingston, Ontario, and they have one daughter, Mrs. John Fisher, who presently resides in Guatemala.

William B. Stout

1880-1956



PLANNING *for* TOMORROW

Extra Fast . . . . .

Aerodynamic Smoothness and Closer Tolerances

IN planning the production of the high-speed jet airplane of tomorrow, production engineers have found that special emphasis must be placed on attaining:

1. Aerodynamic smoothness—of exposed parts—because of the high speeds.
2. Close tolerances—because of the high stresses and high-frequency vibrations.

Result has been a renewed interest in improving old methods of manufacture and devising new ones. Some of the more interesting and important of these will be discussed here briefly. Three phases of the manufacturing process will be covered: (1) forming, (2) machining, and (3) assembly.

Forming

Sheet Metal

Improved forming techniques have been developed to produce parts with the critical aerodynamic smoothness required in the manufacture of supersonic aircraft. They have also been needed to form the high-strength, heavy-gage materials into the sometimes complex 3-dimensional shapes found on these airplanes.

Two fields in which improvements have been introduced are: rubber forming and hot forming.

Rubber forming: Rubber forming is probably the cheapest and fastest forming method used in the aircraft industry. It has been greatly improved in recent years by increasing pressures from a low of 1000 psi for prewar materials to 5000 psi and over to form the new materials of higher strength—such as 78S aluminum, titanium, HSS, and magnesium. Several variations of rubber forming have been developed to use the pressure more effectively.

The Guerin method of rubber forming is generally used. Instead of using the conventional mating die, a rubber pad is mounted inside of a steel holder in a hydropress. (See Fig. 1.) When the hydropress plate descends, the rubber's pliable and nearly incompressible characteristics cause it to transmit pressure in every direction—much as a fluid would—and a metal blank takes the exact form of the die. The Marform and Hydraw processes are based on this same principle.

The Wheelon-Verson process, another variation, involves the addition of a rubber bag on top of the rubber pad. Oil is pumped into the bag, thereby forcing the rubber pad into forming position much more uniformly.

Impact rubber forming is another recent development in the metal forming field. Instead of the costly hydraulic press that would be required for pressures up to 10,000 psi, equivalent pressures can be obtained by capping less expensive drop hammers with rubber heads.

The advantages of impact rubber forming have led to the design of a special drop hammer which will include two lines feeding into the hammer, one line running through a furnace for hot forming parts and the other out in the open for cold forming parts. Since the tool is in contact with the heated metal for so short a time, the part does not cool off and the rubber is not damaged. With the impact rubber forming method, sample (model) parts can be hammer formed with greater speed and more accuracy than previous methods would permit.

It is estimated that the cost of the new hammer will be over a million dollars less than that of a hydroform hydraulic press of equivalent production capacity.

. . . . . Extra Smooth

Are Needed for the High-Speed Plane of Tomorrow

Boyd K. Bucey, Boeing Airplane Co.

Based on paper "Development of Airframe Manufacturing Methods" presented at SAE Annual Meeting, Detroit, Jan. 12, 1956

Hot forming: Heat is an aid in forming metals because it temporarily reduces the yield and ultimate strength of the material. However, there are many problems associated with hot forming and a comprehensive study has provided some optimum forming temperatures for several metals: 325 F is best for aluminum alloys and hard magnesium, 550 F for annealed magnesium and commercially pure titanium, and 1000–1100 F for titanium alloys.

To obtain the optimum forming temperatures, methods of heating the forming dies have also been investigated. Certain systems have been found to be more practical for given temperatures. Steam heating of the dies (Fig. 2) was found to be best for temperatures up to 350 F; hot oil pumped through the dies proved adequate for 550 F, and the internal combustion of premixed gas (Fig. 3) is best for temperatures over 1000 F.

Titanium, which, in most cases, requires forming between 500 and 1000 F, presents a special hot forming problem. Each alloy of titanium must be considered separately since the proximity of the yield and the ultimate strength points varies from alloy to alloy and at different temperatures. Another concern is the change in elongation and reduction of area which vary along the temperature range. Therefore, each operation for each part is a case in itself and the individual factors must be considered for titanium forming operations.

Internal Structures and Fittings

There is keen interest in a new manufacturing approach which eliminates difficult and expensive machining operations. Material manipulation (chipless production) is represented by several new or improved manufacturing techniques.

Precision casting: Precision high-strength casting, still in the development stage, promises castings which will have the strength and precision required to meet primary structural needs.

Precision forging: Larger and more precise forgings are forthcoming as a result of the heavy forging press program being sponsored by the United States Air Force. As soon as a few production problems

Fig. 1—Detail tools for routing and forming parts.

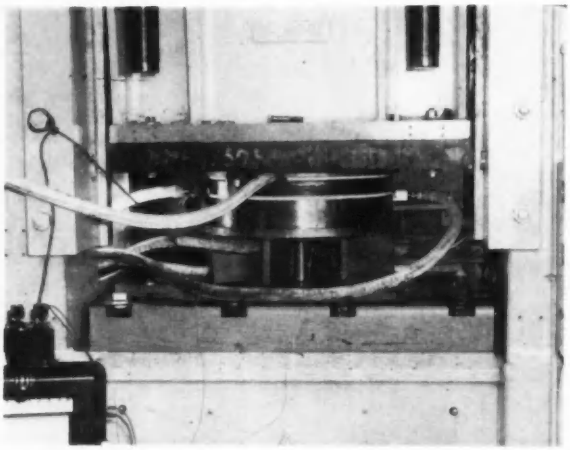


Fig. 2—Steam-heated draw die.

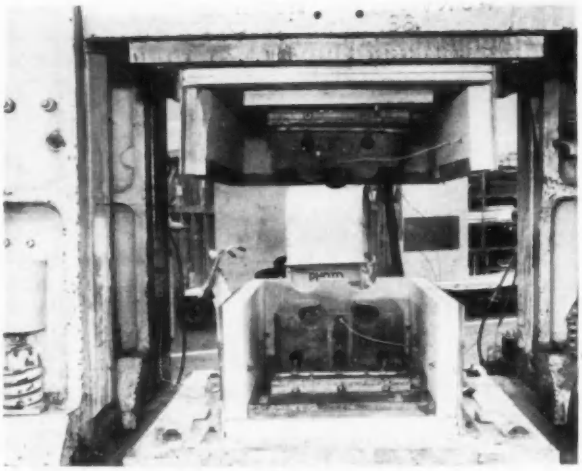


Fig. 3—Gas-heated hammer die with end removed for clarity.

have been licked, it appears that precision forgings with little or no draft angle and very thin walls and legs will be feasible. Thus, finish machining will then be required only on critical fairing surfaces, thereby reducing costs appreciably.

Extrusions: More complex and sizeable parts can be extruded to close tolerances. This method of squeezing heated metal through a die results in material savings, low cost production, and less weight. Further, the extrusion of complete sections eliminates subassembly joining operations.

Impact (cold) extrusion is no longer limited to the forming of radio tube covers and other small, simple items. The recent cold extrusion of aircraft shear tie fittings, which have irregular sides and varying wall thicknesses, indicates that the method may be used for larger parts. In addition, cold extrusions have the advtange of having more tensile strength than hot extrusions since metal recrystallizes when hot worked.

Aluminum powder metallurgy: Aluminum powder metallurgy has been improved by the addition of 10–30% aluminum oxide to the pure aluminum powder used in the sintering process. (Sintering is the process of cohering metallic particles under heat and pressure.) Sintered parts containing aluminum oxide show improved creep resistance above 450 F. It is possible to produce sheet stock by rolling a sintered bar. It is hoped that further research will increase the strength to weight ratio of this material and extend its usefulness to some applications where present aluminum alloys cannot be used.

Machining

Machining equipment and techniques have been radically improved to manufacture with the required accuracy the larger, heavier, and stronger internal structures and fittings of airframes for jet aircraft. Three new processes that appear to have real possibilities in this field will be discussed: chemical milling, electrical erosion, and ultrasonic vibration.

Chemical Milling

Chem milling is an improved etching process. It was originally applied by North American in conjunction with Turco Products, Inc. Certain areas of the metal slab are masked, then the slab is immersed in a suitable solution (for example, caustic, for aluminum). The etched slab is removed from the solution when the desired depth has been obtained. This is determined by clocking the immersion period. With such simple controls, accuracy within 0.002 in. can be obtained.

Steel forgings may soon be chemically machined. This method is expected to reduce the time now needed to make a precision forging. Instead of making several dies for the various stages now required to produce a precision forging, one die, made with oversize web and flanges, will suffice. The web and flanges would then be reduced to the desired thickness by chem milling. Precision forging dies, then, could be chemically milled much faster and more economically than by present machining methods.

In addition chemical milling has proved to be the most advantageous process for producing integral skins. Tapered skins can also be chem milled by removing the skin from the solution gradually. Another feature is that several parts can be etched at once, and only simple tank equipment is required. Unlike machining operations, chemical milling does not call for a skilled operator.

Electrical Erosion

Heretofore, electrical erosion was primarily used for the removal of broken drills and taps. During the past few years this type of machining has been expanded to the production of small molds or forming dies. It is rapidly taking its place among other types of machining processes.

Electrical erosion may be described as the reversal of the electroplating process, which is so extensively used in many phases of industry. The work to be machined is first immersed in a dielectric fluid along with an electrode, which has been shaped to the

desired cut. The work and the electrode are set apart with a gap of 0.0002–0.0015 in. The current is introduced and a series of electrical discharges occur between the electrode and the work at rates of 20,000 to millions per second. Consequently, portions of the work are heated to their vaporization point and, as they move towards the electrode, are washed away by a coolant. The accuracy to which parts are machined by the electrical erosion process depends directly upon how accurately the electrode is made.

As an example of the economy of the electrical-discharge machining method, a comparison with the conventional method of making a die for an impact extrusion press shows that 174 hr of skilled labor are required to shape, drill, file, grind, and lap or hone such a die, while the electrical-discharge method requires only 50 hr.

In addition, electrical erosion is accurate to within 0.0002 in. This extreme accuracy has created particular interest throughout the aircraft industry because of the possibility that electrical erosion may be used to machine metal honeycomb structures accurately.

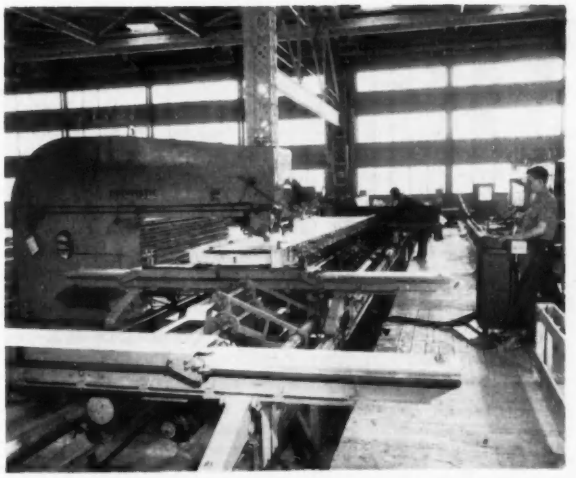


Fig. 4—Photo-electrically controlled General Drivmatic riveting machine.

Ultrasonic Vibrations

The process of ultrasonic machining was originally used to machine intricate dies and grind chip breakers in carbide tools. It is now being evaluated in other applications such as grinding, boring, threading, and machining any brittle material.

Ultrasonic machining is essentially the high-frequency vibration of a steel tool against the workpiece when both have been submerged in water containing a fine-grained abrasive.

Because this process involves very low stress and no local heating, very brittle materials such as carbides, heat-treated steels, titanium, and glass, can be machined without altering the physical or chemical characteristics of the material.

The high-frequency vibration method is also very valuable for its ability to clean complicated parts thoroughly and rapidly. It is used for soldering and, more recently, for revealing internal flaws in metal bond and honeycomb assemblies. The new high-frequency vibrating machines developed by L.M. Electronics are capable of vibrating entire airframes to programmed tests to evaluate structural rigidity.

Fig. 5—Spoiler skin on platen preparatory to bonding.

Assembly

Jigging

Today's large airplanes have complexly curved shapes. Moreover, aerodynamic smoothness specifications and their interchangeability requirements demand ever greater accuracy in tooling. Manufacturing has overcome some of these formidable design requirements by dividing the airplane into smaller sections in assembly, and by improving tooling or jigging techniques.

Optical tooling: Optical tooling has reduced the time taken to erect a jig by 25%. A high degree of accuracy is attained: ± 0.002 at 50 ft and ± 0.006 at 150 ft. Methods of using precision telescopes, targets, and planizers to establish reference points and planes for jig erection have been improved.

The latest refinements in electronics have merged

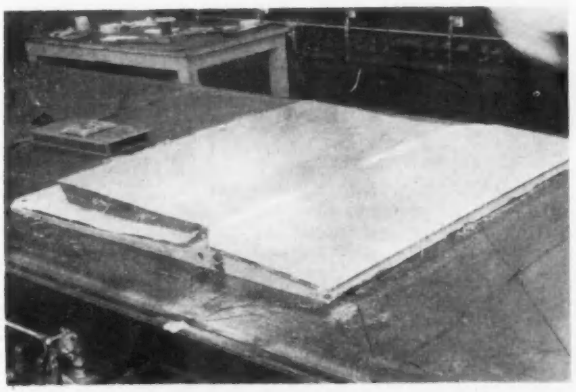


Fig. 6—Skin bonded to honeycomb core for airplane spoiler.

with the new optical tooling methods. Television has entered the field. The very close alignments require an average of 6–8 readings. Closed-circuit television systems enlarge an image, permitting a single reading which is even more exact. Optical instruments are also proving useful in such other applications as erection and setting of master models. Optical tooling methods (called harmonization) were recently applied to align the complex electronic firing system on a jet bomber. One hundred man-hours were saved on each airplane.

Concrete jigging: Concrete has replaced steel for large jig bases. Strong in compression, weak in tension, it is able to absorb shock loadings and machine vibrations. Its availability, low cost, and the reduced jig erection time required outweigh the importance of some of concrete's unfavorable characteristics. It has recently been considered for use as scaffold structures for major jigs and as base beams and rough structures in jig construction.

Aluminum jigging: With the advent of larger jigs, the expansion differential between steel and aluminum became a critical consideration. Aluminum is now being used extensively in jigs over 35 ft long to reduce the difference of expansion of the tool and the part.

Over 300,000 lb of aluminum, made into castings which range from small components weighing 4 or 5 oz to 6000-lb end gates, are being used in the jigging for a current jet plane. Where two or more duplicate units are required, the use of these castings has cut costs in half.

Fastening

While researching into the design and manufacturing problems encountered in the production of integral skins, the aircraft industry has also been improving on composite types of construction. Composite skins may be riveted, spotwelded, metal bonded, or sandwiched. They may consist of metallic and nonmetallic materials.

Riveting: The majority of composite structures are still riveted. There are about 180,000 bolts and rivets in each wing of a heavy jet bomber. Hence, riveting remains as the most costly single item of airframe manufacture. A recent improvement in this field is the hi-shear rivet, made of steel or aluminum alloy, and secured by collars swaged into locking grooves.

Automatic riveting machines are being used to produce high-quality rivets to close tolerance. (See Fig. 4.) Accuracy and uniformity can be maintained at speeds up to 15 rivets per minute.

These machines can rivet major assemblies, such as entire wing panels up to 40 ft long. They are controlled for transverse and longitudinal movement by punched 35-mm tapes. They will automatically drill and countersink a hole, insert a slug, upset both heads, and shave the exterior head flush. They will then recycle for movement to the next position. Some machines are also equipped with cycles for spot-heating and coin dimpling.

Welding: The development of 3-phase spotwelding machines has made more reliable spotwelds possible. This equipment features better control of the current during each step of the spotwelding process.

With earlier equipment, current control was limited to the heat application for the weld phase. Lack of this control during the next, forging phase often resulted in a cracked weld, since uncontrolled, rapid cooling allowed the outside of the molten "nugget" area to harden before its core. Now, the current decay that follows the weld charge can be checked during the forge. Thus, with the new 3-phase spotwelding machines, the molten "nuggets" can be tempered evenly.

Metal bonding: The use of new adhesives and plastics has improved metal-bonded aluminum and magnesium structures. (See Figs. 5 and 6.) Airframe structures made by this bonding process (cementing or glueing under pressure) not only makes an airplane lighter, but stronger. Moreover, thousands of man-hours are being saved by metal bonding structures because the fewer parts require less fabrication time. Machining, drilling, riveting, and other operations usually needed to make comparable components are eliminated.

The metal bonding of a very thin skin to a honeycomb core or laminated structure is proving to be the most satisfactory means of providing the stable airfoil surface necessary to overcome the structural fatigue caused by the high-frequency vibration to which jet airplanes are subjected.

Metal honeycomb is used as the core of metal-bonded components that require a rigid, strong structure, such as an airplane flap panel. (See Fig. 7.) Balsa wood, foamed plastic, and paper are also used as fillers. A more effective means of machining the metal honeycomb to the compound curvatures often required has been developed. An ordinary valve stem was hollow-ground to a knife-like edge. Driven by an air motor, this small, circular blade is able to cut compound curvatures in honeycomb structure to tolerances of 0.001–0.002 in. If the desired curvature is critical and complex, the honeycomb is stabilized before machining by filling it with a low-melting plastic or water which is subsequently frozen.

For complete paper (in multilith form) on which this abridgment is based write SAE Special Publications. Price: 35¢ to members, 60¢ to nonmembers.

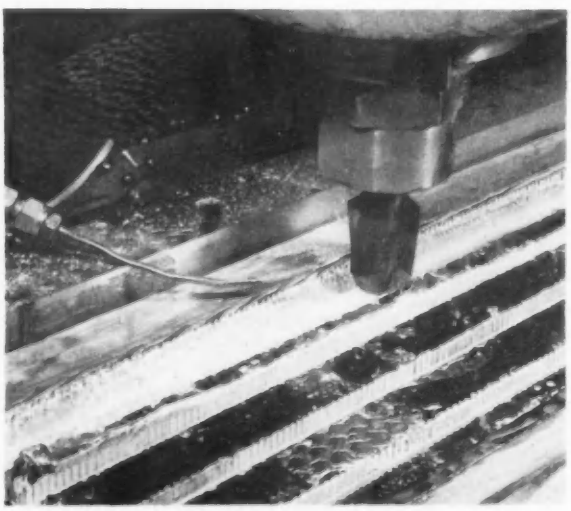


Fig. 7—Milling stabilized honeycomb structure.

NEWS of the SAE

PRODUCTION MEETING

March 19-21, 1956 Hotel Statler Cleveland, Ohio

Russians Stress Automation As Way to Out-Produce USA

Production Meeting Told Russia Ahead of Some American Practices; Automotive Techniques Lag; Ceramic Tools Used

CLEVELAND, O., March 24, 1956 (SAE)—Russian engineers are going all out to apply automation to many manufacturing operations in an effort to increase output greater than the United States, two American engineers told the SAE National Production Meeting.

While Russian factories are crowded and housekeeping and illumination are poor by American standards, the Russians are building new automatic machines and engineering production lines that "would be a credit to any engineering group anywhere," it was reported by A. C. Hall, Bendix Aviation Corp., and N. L. Bean, Ford Motor Co.

The speakers, who visited Russia last December, said if the plans they heard about are carried out, within 10 years many Russian production facilities will be comparable to ours, and within 15 years they may be superior to ours unless a new emphasis is placed on automated production designing in this country.

The 250 SAE members and guests gathered at a luncheon in Cleveland's Hotel Statler were warned that we have consistently underated Russia's basic research in nuclear power. In other basic science and research fields they are surprisingly advanced. All work is under government control.

The government-controlled Academy of Science guides all re-

Continued on page 81

N. L. Bean, Ford Motor Co. (left), and A. C. Hall, Bendix Aviation Corp. (center), give D. S. Kimball, Jr., private impressions of Russia's productivity prior to the luncheon at which Bean and Hall told of their recent Soviet tour.

536 Engineers Attend Production Meeting Forum in Cleveland

PRODUCTION engineers from widely scattered parts of the automotive industry gathered in Cleveland March 19 through 21 for the three-day SAE Annual Production Forum and Meeting.

Nine panel sessions for the discussion of automotive production problems were scheduled.

Subjects included manufacturing expense control, capital spending, forging of rare metals, shell molding, indoctrination and training of college graduates, communications, purchasing, free machining metals, and the customer's point of view.

The meeting was sponsored by the SAE Production Activity with the cooperation of the Engineering Materials Activity and the SAE Cleveland Section.

General Committee for the meeting was: D. S. Kimball, Jr., chairman; E. K. Brown, vice chairman; J. E. Adams, C. A. Bierlein, E. F. Gibian, A. D. Gilchrist, R. F. Steeneck, T. R. Thoren and F. L. Zirbes.

College Students Sing at Luncheons

SAE members attending Monday's luncheon were entertained by two young music students, a soprano and a baritone, from Oberlin College who sang selections from opera and musical comedy.

On Tuesday, the Fenn College Choir entertained at the luncheon with selections from Gilbert and Sullivan.

Case Tech President Predicts:

Atom's Peacetime Future

THE atom is destined to change our way of life and we might as well plan to adjust our industry, economy, and society to it.

That's what T. Keith Glennan, president of Case Institute of Technology, reported at the luncheon session on Monday, March 19. This was the implication drawn from the McKinney Panel report, the highlights of which Glennan discussed. Aim of the McKinney Panel, which had recently released its report, was to appraise the impact of peaceful nuclear applications on our way of life.

T. Keith Glennan

The report urged continued development to produce electrical power using nuclear fuels. The program is expensive. If industry can't foot the entire bill, the Atomic Energy Commission should shoulder part of the burden, said the report. It also urged construction of at least one full scale reactor plant of each type.

The McKinney Panel recommended continued and expanded use of the atom and its radioactive by-products in medicine and public health, agriculture, food sterilization, and industrial research.

Glennan forecast a Naval fleet entirely nuclear-powered in the future. He said the report recommends construction of nuclear commercial ships, with support from the AEC and the Maritime Commission. As for an atomic-powered airplane, Glennan predicted an expenditure of $750 million to $1 billion before the first one will fly.

Someone will have to take up the leadership in stimulating development of peaceful uses of the atom, said Glennan. Should it be government or some other agency, he asked.

Locomotives look like a possibility. But you can play with the gas turbine for a long time to come without fearing the advent of nuclear propulsion, Glennan told passenger car engineers.

A change in legislation will be needed. For instance, today all atomic information is born classified. Getting it declassified is a painful process. Why not have information born unclassified, he asked.

Manpower will ultimately be the limiting factor in developing peaceful uses of the atom, observed Glennan. He asked industry not to woo away teachers from colleges and universities. They are sorely needed to train new scientists and engineers in the nuclear field.

"THIS IS AUTOMATION" FILM SHOWN TO PANEL

AN informative film entitled "This Is Automation" was screened during the panel session on Capital Spending. This 20-minute color, 16-mm movie showed the steps various industries have taken to automate or upgrade the mechanization of handling, making, inspecting, assembling, testing, and packaging functions of manufacturing. It was produced by General Electric Co.

Forum Leaders

Leaders of the seven Production Forum Panels were:

T. W. Curry, Lynchburg Foundry Co.

E. O. Dixon, Ladish Co.

E. F. Gibian, Thompson Products, Inc.

G. B. Howell, General Electric Co.

R. D. Long, International Harvester Co.

H. A. Williams, Eaton Mfg. Co.

E. L. Yates, General Motors Corp.

Secretaries of the seven Production Forum Panels were:

L. E. Wile, Lynchburg Foundry Co.

L. E. Howell, General Motors Corp.

A. E. Stukey, Thompson Products, Inc.

J. F. Spaulding, Cleveland Diesel Div., GMC

S. E. Kelker, General Electric Co.

R. C. Ochs, Eaton Mfg. Co.

E. Foley, Ladish Co.

$35 Billion To Be Spent On Capital Goods

AN all-time high of $35,000,000,000 will be invested in capital equipment and buildings by industry in 1956, it was estimated at the panel on Capital Spending. During the next 10 years a 50% increase in productive capacity will be needed to meet increased consumer demands.

Since the labor force will increase only about 14%, industry will have to step up its mechanization and automation programs and plan for full use of its plants, machinery, and equipment.

The main problem facing management during this period will be knowing when and how much to invest in new type equipment for optimum cost reduction, flexibility, and depreciation. Solution will probably be found by "task groups" which will analyse each specific case.

Caught in the competition to increase production capacity is the smaller manufacturer whose funds are limited. Electronically-controlled, automated machines may shorten the manufacturing cycle, cut lead time, and provide a certain amount of flexibility, but they are usually too costly for short run manufacturers like air frame and some truck builders.

Russian Automation

Continued from page 79

search in Russia and has set up laboratories with excellent equipment and well-trained, alert scientists and engineers. In the field of non-linear mechanics they are ahead of us in theory and probably in practice.

The two engineers saw some outstanding applications of electronic and mechanical automation during a tour of machine tool, ball bearing, and automobile plants. They saw many tracer-type lathes and one production line that completely automatically assembled 54 turret lathes a day. This continuous assembly line is capable of turning out 1000 machines a month.

They saw an automatic balancing machine designed to balance an electric motor armature. The machine determines the area of unbalance, then automatically sets into motion cutting heads which cut out enough metal to correct the unbalance while the armature is fed through the machine.

Ceramic tools were being used on experimental lathes which the Russians claimed were operating at a surface speed up to 900 meters per minute. The Russians said they were producing an 80 micro finish with these ceramic tools.

During a visit to the Gorki Automobile Plant and the Stalingrad Tractor Plant, the visitors found production techniques below those in this country.

However, the Kaganovich Ball Bearing Plant had a fully-automated line capable of producing 60 million bearings a year. Hot-rolled forgings were dumped into hoppers at the beginning of the line, and all operations, including handling between processes, heat treating, grinding, inspection, assembly, tests, and packaging the bearings in cardboard at the end, are automatic. From an engineering standpoint, the Russian line looked more advanced than American ball bearing plants, according to Hall and Bean.

More than half of the 12,000 employees at this plant are women and about 30% of all Russian engineers are women, they said.

A key factor in the future development of the Russian industrial potential is the country's educational system. More than 800,000 students are enrolled in science and engineering courses. Ninety-six percent of Moscow University students receive stipends and scholarships, with bonuses for excellent grades. University laboratories are better equipped than most American Universities.

At current graduation rates (2½ times American rates) the Soviets will soon have a much larger pool of trained engineers and technicians. From what the visitors saw the quality of these new graduates is very good. The speakers said: "It is entirely possible that Russia can quickly narrow the gap between their capacity and ours. They already have men who know how to improve their productivity, and they are training thousands more."

PRODUCTION MEETING and Forum leaders were: (left to right) T. R. Thoren, chairman of SAE Cleveland Section; D. S. Kimball, Jr., chairman of the general committee; and J. E. Adams, chairman of the Production Forum. E. K. Brown, not in the picture, was vice-chairman of the general committee, and special committee chairman for entertainment.

Customers Inspect Processes, Products

GIVING the customer what he wants can be assured in the automotive industry by shifting most of the responsibility of quality inspection on his shoulders, it was suggested at the Production Forum panel, The Customer's Point of View. Quality is being controlled more and more by the customer. What he demands becomes essential; nonessential quality is being culled out in cost reduction programs.

In general, production of higher quality is being achieved by the use of automatic gages on machine tools, and by shifting the customer's point of inspection from the finished product further back in the production process. Particularly in high volume jobs, the chief inspector is checking tools and processes instead of waiting for the complete product to be finished.

Definition of quality levels are becoming more precise through interpreting design rather than merely following blueprint specifications. Inspection departments are paying more attention to field experience and performance reports from the customer than ever before, too.

PRESIDENT G. A. Delaney awards plaques to J. E. Adams and D. S. Kimball, Jr., in appreciation for their leadership and efforts in guiding the 1956 National Production Meeting and Forum. Kimball was general chairman of the meeting in Cleveland as well as meetings vice-chairman for the Production Activity. Adams was chairman of the Production Forum.

New Developments In Free-Machining Steel Metallurgy

STEEL metallurgy is being controlled much more closely in an effort to increase machining rates. It has been found that cold drawing of low carbon steels will increase machinability better than hot rolling. Also, to help machinability it is desirable to provide a lubricant such as manganese sulphide within the steel. This will reduce the friction between the tool and the metal and give a better surface.

The panel on Free Machining Steels advised that too much silicon in steel will cause cutting difficulties, and carbon must be kept lower than 0.10% for easy cutting.

Leaded steels also have good machining characteristics.

Hunt Low-Cost, High-Temp Metals For Gas Turbines

To use more "Exotic" Metals

AUTOMOBILE manufacturers are looking to a future of gasoline turbine engines, but they will need alloys that can take high temperatures and high rotating speeds, E. O. Dixon, leader of the panel on Forging of Rare Metals, said. Metals that can do the job now are alloys of nickel, chromium, and molybdenum. The search is for metals with lower costs and for those not on the Defense Department's critical materials lists.

Increased use of "exotic" metals and their alloys has come about due to the development of the consumable electrode process of melting. This method, in which the electrode is its own source of metal, when combined with low pressure and rapid cooling, has produced alloys low in gas content, with uniform density, and with minimum segregation.

Double electrode melting has yielded alloys of exceptional uniformity. It is being used to melt not only rare metals but other high temperature alloys formerly melted by arc furnace methods.

Titanium in the aircraft fields, and zirconium in the atomic energy industries will be used more and more, it was predicted. In 1956, 9 to 10 million pounds of titanium will be used for mill products. About 70% will be used in making forgings. Forging titanium and the other new metals economically and efficiently is a major problem still to be solved.

Too, some economical method of salvaging titanium scrap is sought. Use of electrolytic methods of refining titanium may help the salvage problem.

Use of molybdenum and its alloys at high temperatures will be increased as soon as better coatings to resist oxidation and erosion are developed.

One panel member reported that molybdenum ingots can be converted more readily by extrusion than by hammer reduction. However, furnace temperatures of 3000 F are required to dissolve intergranular carbides in the metal and give good transverse ductility.

FACE-TO-FACE discussion about new developments in engineering materials occupies W. E. Jominy, SAE vice-president for Engineering Materials Activity, and E. C. Smith, chief metallurgist, Republic Steel Corp.

SAE Tours Alcoa, Republic Plants in Cleveland District

THE SAE Production Meeting and Forum was welcomed to Cleveland by two of the area's largest companies throwing open their plants for conducted tours.

Three busloads of SAE members and guests visited the Aluminum Company of America—U. S. Air Force Heavy Press Plant on Wednesday morning. They saw the 35,000 ton United Press producing aluminum forgings for Air Force bombers. The 50,000 ton Mesta Press was not operating. The complete story of the Heavy Press plant begins on page 18 of this issue of the SAE Journal.

Republic Steel's Cleveland District Plants were host at a box lunch on board the buses. Then the visitors were conducted through the 98-in. strip mill. Complete story of this tour through the widest strip mill in the world begins on page 50 of this issue of the SAE Journal.

Technical Background Is Prerequisite For Purchasing Personnel

THE PANEL "To What Extent Should Purchasing Participate in the Technical Aspects of Manufacturing" generally agreed that technical people should have a large say in buying finished parts for the final assembly of a product. In purchasing rough stock for final manufacturing within the company, technical qualifications are not so important.

Many organizations have the Follow-up or Expediting function directly under the supervision of the Purchasing Department. In these cases Purchasing personnel with technical backgrounds are very desirable. Technically-trained personnel are in a better position to recognize a possible cost reduction or a better method of procedure to reduce costs. Also, they are better qualified to meet sales engineers and specialists.

Panel Leaders Briefing . . .

BEFORE THE FORUM sessions begin, panel leaders are briefed in their duties by Forum Chairman J. E. Adams. Left to right: Adams, G. B. Howell, E. L. Yates, H. A. Williams, E. F. Gibian, E. O. Dixon, R. D. Long. T. W. Curry was also a panel leader.

To Overcome Engineer Shortage:

More Liberal Arts Graduates Will Be Hired

A PANEL of industrial and educational experts agreed that one way of solving the current engineer shortage is to use more liberal arts and business administration college graduates in jobs they can be trained to do in manufacturing and other technical areas.

Another way is to select and train non-graduate technicians to relieve qualified engineers of non-engineering duties.

It was estimated that 24,000 technical students will be graduated in 1956 and that there are more than twice that many technical jobs to be filled.

Industry must continue to train and help finance graduate engineering study after hiring a young engineer. There is not enough time in the 4-years college course to turn out a completely trained engineer. Many companies are paying half or more of the tuition fees for graduate study.

Some companies are looking for bright workers in their own shops that they can send to college and train for engineering or management jobs. The shortage of good potential management personnel is as great as technical personnel, the panel audience was told. Only by giving young engineers early responsibilities, and training them to become executives will industry meet these needs.

Many colleges, faced with the dilemma of eliminating either practical shop courses or advanced science studies in the overloaded engineering student's curriculum, are looking to industry for guidance. They ask, "Should students be taught basic science in school and left to pick up practical shop techniques afterwards, or should they be given more laboratory work in school?" A member of the panel on Indoctrination and Training of College Graduates for Manufacturing, who was also a senior at Case Institute, expressed the hope that both engineering and science courses, as well as a thorough grounding in liberal arts, will be provided, even if the undergraduate course must be lengthened to five years.

Eastern Snowstorm Reshapes Meeting Session on Communications

ONE of the smoothest pinch-hitting jobs in SAE history was performed at the Tuesday morning session on "How to Communicate Ideas in the Factory," when snow in the east side-lined the scheduled speaker, Dr. Alex Bavelas, of MIT. Credit for the behind-the-scenes operations goes to General Chairman Dexter Kimball, Vice Chairman Ned Brown, and Session Chairman Emil Gibian.

Last-Minute Telegram

When Kimball received a wire on Monday afternoon from Dr. Bavelas saying that he was snowbound in Boston and couldn't get to Cleveland, Kimball swung into action. He, Brown and Gibian got on the phone and lined up a panel of communications specialists in about one and one-half hours.

The swiftly-mobilized panel consisted of:

- Robert R. Tufts, director, Management Development Center, Case Institute of Technology
- Henry W. Hopwood, assistant director of public relations, Republic Steel Corp.
- A. N. Sheahen, personnel manager, Tapco Plant, Thompson Products, Inc.
- W. O. Uraneck, supervisor, Salaried Personnel and Training Section, Industrial Relations Department, Cleveland Plants, Ford Motor Co.

Vigorous discussion and enthusiastic audience reactions during and after the session proved that the Kimball-Brown-Gibian action had turned a near-calamity into a smash success.

Frontline Foremen Seen Responsible For Budget Control

CONTROLLING manufacturing expenses can be accomplished effectively only if frontline supervisors are made to assume the responsibility of following the budget, it was stated at a panel session on Manufacturing Expense Control.

Some companies base budgets on engineered standards; others estimate costs as a percentage of sales price and estimated volume. In general the trend is towards budgets determined from engineered standards for indirect labor, supplies, and other expenses, in addition to direct labor costs. However, considerable revamping of present budget control techniques is needed because automation is reducing the amount of direct labor. Overhead and maintenance costs are assuming a greater proportion of operating expenses than direct labor on automated production lines.

A major problem in the automotive industry is labor misconceptions about the shift from average or historical standards to high-task engineered standards. One panel member warned that thorough indoctrination of all supervisors, hourly employees, and the union in the purposes and advantages of high-task standards is necessary.

He said high-task standards do not necessarily place a harder load or require more pieces from the worker, and they have the advantage of being more reliable and uniform.

For Improved Communications, Educate Foremen

REALIZING the need for better communications between management and labor, many automotive companies have set up training programs for educating their first line supervisors—the key men in the chain of communications.

At the panel on Communications, a spokesman for Republic Steel told of the successful completion of a program that increased the "economic understanding" of its employees. Subjects included basic economics and management problems, as well as more personal discussions on wages, and planning for retirement. First line foremen were instructed during compulsory discussion sessions, once a month for 15 months.

A controlled survey before and after the courses indicated that the foremen improved their knowledge and revised a large part of their preconceived, anti-company opinions. This resulted in fewer work stoppages, better product quality, and higher morale.

New Potentials For Shell Molding

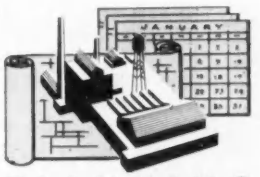
RECENT developments in shell molding techniques and equipment are permitting engineers to design castings with straighter walls, with more complicated contours, and with less excess material, the panel on Shell Molding informed the largest session at the Production Forum.

This revolutionary casting process uses phenolic resin and sand (instead of conventional green sand) to make molds. It eliminates "shift," permits the addition of ribs to strengthen casting design, and increases machine tool life. One large automobile company estimates that 63,000 tons of its castings will be made by shell molding in 1956. That's more than three times the amount of shell-molded castings produced by this same company last year.

Although shell molding will not permit complete by-passing of the machine shop, as was first expected, it does permit casting to closer tolerances, thereby reducing the amount of metal that must be removed by machining. This increases tool life.

If tolerances are specified realistically, costs can be reduced considerably. One company reports savings up to 90% by using shell molding instead of forging for some parts.

Costs are being lowered in making patterns from shell molding. In one foundry 80% of the patterns are made of aluminum, although cast iron and bronze patterns are used, too. Aluminum patterns are used mostly for low production work, less than 2000 molds per year.



Let's Tolerate The Tolerance

Realistic tolerances form the connecting link between efficient design and economic production.

Garmon D. Simmons

quality control engineer, North American Aviation, Inc.

Based on one of the papers given as part of the Aeronautic Production Forum at the SAE National Aeronautic Meeting, New York, April 10, 1956.

THE essentials of a successful manufacturing operation can be defined as "good design coupled to efficient production using economic manufacturing tolerances." This connecting link, "tolerances," serves as the common meeting ground between the two factors and has a major effect on production output, costs, and product performance.

A tolerance describes the designer's conception of allowable parameters. This is determined by such factors as performance, fit, and machinability. So, for the tolerance to fulfill its intended purpose successfully, it must be approached with a compromising point of view. Without such an approach, the whole conception of tolerances could easily result in misunderstanding between the designer and the production supervisor.

Most organizations have a system for the review and solution of problems involving tolerances. This solution, usually, reflects a practical consideration of production conditions. However, much time and effort are often wasted before these problems are satisfactorily resolved. These delays incur additional costs which could be eliminated if sufficient data were available to the design engineer.

Let's take a look at some of the quality control methods that are available to the engineer to aid in the solution of such problems. Consideration will be limited to the quality control analysis of typical machine part tolerance problems and the associated feedback of pertinent, factual data to the production department and design engineering group. The examples which will be mentioned were obtained from actual cases witnessed in a heavy machine parts section by the author.

Frequency Distribution

A quality control study usually requires one or more production part runs to compile enough data on which to perform a complete analysis. Only then may the variables inherent in the machine, material, and man be reduced to known facts. Experience has shown that most of the problems involving tolerances can be quickly and economically resolved after these facts are properly analyzed, and the pertinent information made available to the engineering group.

As design problems regarding like or similar operations arise, the factual machine and process capabilities provided by previous quality control studies can be used by the designer.

The simplest yet most effective initial step in any investigation is a "frequency distribution chart." These data can be economically compiled by the production operator when he measures and records the dimension of each part as it comes from the machine. Each square in the frequency distribution represents one measurement for one part with that dimension. In Fig. 1, for example, there were two parts that had a reading of 0.0645 in. and 11 parts with a 0.0640 in. reading. The frequency distribu-

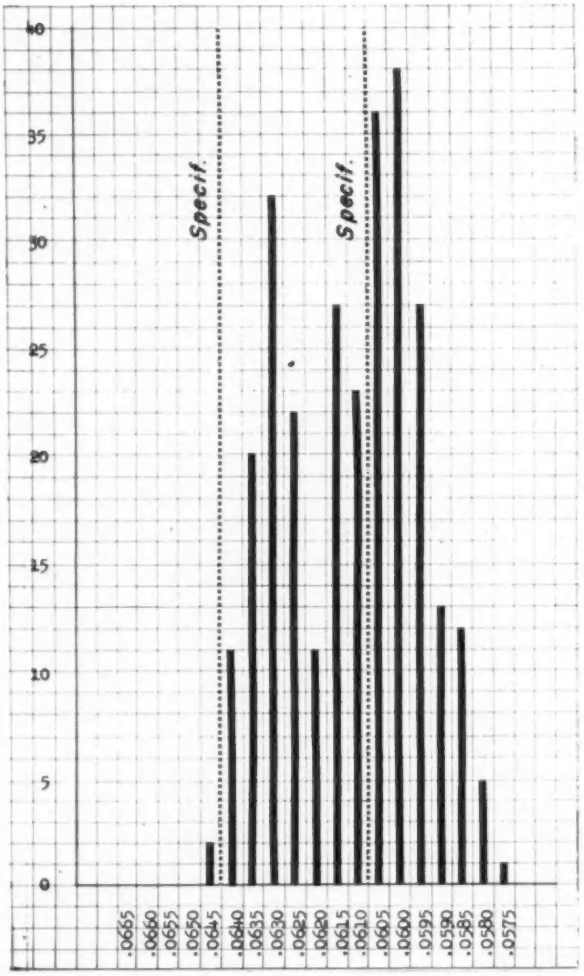


Fig. 1—A typical frequency distribution chart. Each square in the frequency distribution represents one measurement for one part with that dimension. The distribution of this chart indicates that a more complete analysis of the machining operation and the operator's technique is necessary. Specifications called for a dimension of 0.0625 ± 0.0015 in.

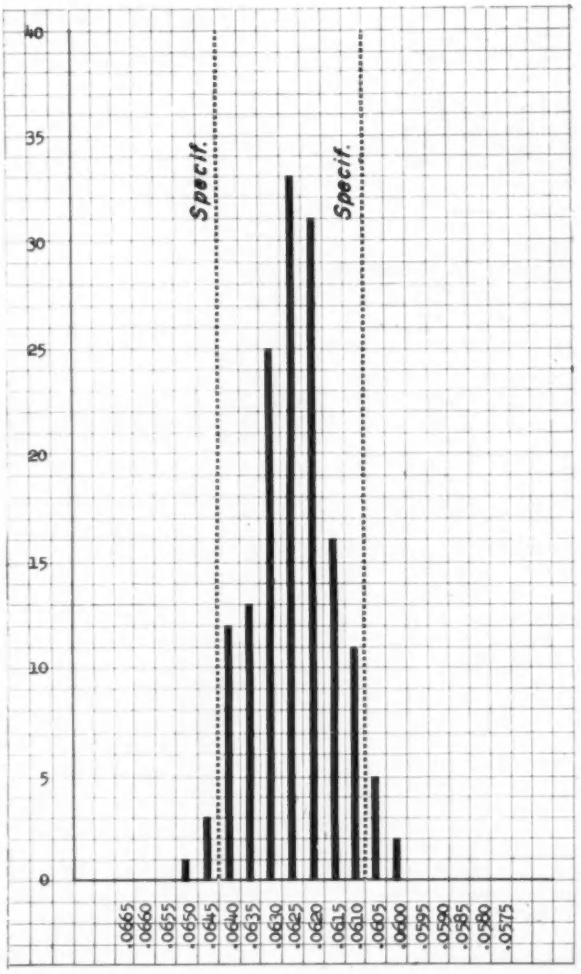


Fig. 2—By training production department personnel in the proper interpretation of blueprint tolerances, making tooling corrections, and getting better coordination between shifts, the distribution of Fig. 1 has been corrected to one more closely approximating the desired "bell shape."

tion chart indicated that a more complete analysis of the machining operation and the operator's technique was necessary to eliminate the following undesirable conditions:

A. The vacuum holddown chuck, used to position the part during machining, was not in the proper relationship to the cutting head.
B. A tool-bit cutter was changed, but was not reset to original cutting depth by the operator.
C. The problem of day and night shift coordination was evident.

One portion of the corrective action program that resulted from this analysis was concerned with additional training for the production department personnel and stressed the proper interpretation of blueprint tolerances. Demonstrations showed the importance of having the operator "shoot for the middle" of the tolerance thus eliminating the standard machine shop practice of machining to the high side of the call out.

This improvement, in addition to the tooling corrections and better coordination between shifts, resulted in the frequency distribution shown in Fig. 2. This distribution more closely approximates the desired "bell shape" or normal distribution. However, when the actual part measurements were compared with the blueprint specification of 0.0625 ± 0.0015 in., it was found that a high percentage of the parts still exceeded the blueprint specification.

With the aid of the frequency distribution analysis sheet (Fig. 3), these percentages could be estimated with a reasonable degree of accuracy as the shaded areas indicate. It can be safely assumed that further production would result in 5% of the parts being over tolerance and 7.5% of the parts under tolerance or a total of 12.5% of the production outside of the blueprint specifications. This may also be expressed as an acceptability rate of 87.5%.

Although this was a marked improvement over

the original conditions, it still did not represent an economically satisfactory level since the total expected spread of approximately 0.006 in. would require excessive rework and materials review cost. This is shown by a comparison of expected limits to blueprint specifications on the frequency distribution analysis sheet of Fig. 3.

Repeated efforts to improve further the existing conditions were unsuccessful. Consequently, the subject was submitted to responsible management personnel representing manufacturing, engineering, and quality control. Three alternatives were available. These were:

1. Purchase new equipment capable of holding the existing tolerance.
2. Continue the production with the high rejection rate.
3. Review the requirement for the existing tolerance.

After a thorough review of the available alternatives it was found possible to adopt a tolerance of ± 0.003 in. in lieu of ± 0.0015 in., with the condition that production would continue to maintain the frequency distribution charts on succeeding releases. The present acceptability rate for these dimensions is 97%.

The following are company benefits derived from this effort:

- Definitive data regarding machine capability has been made available to the design engineer. This information will assure him that future parts of similar design requiring comparable tolerances can be machined within this shop demonstrated ability.
- The production foreman now is certain of the machine capability of his equipment. Future parts requiring similar tolerances can be assigned to these machines, thereby reducing the possibility of rejection.
- As the production operator plots the measurement for each part on his frequency distribution chart, he will always know exactly where his part measurement is in relation to the blueprint specification. This further decreases the possibility for an operator to run an entire release of parts in error.
- The resultant savings in rework, reduction of material review action, less time required to produce and inspect each part, and a more satisfactory product is balanced against the time required for the machine operator to note the measurement on a frequency distribution chart.

Accumulated Tolerances

In another example, a drawing called for the overall measurement on a part to be held to ± 0.006 in. The shop was experiencing considerable difficulties in machining this dimension and many of the parts had to be submitted to materials review for disposition because the dimension was not within blueprint specifications. Several requests to engineering to

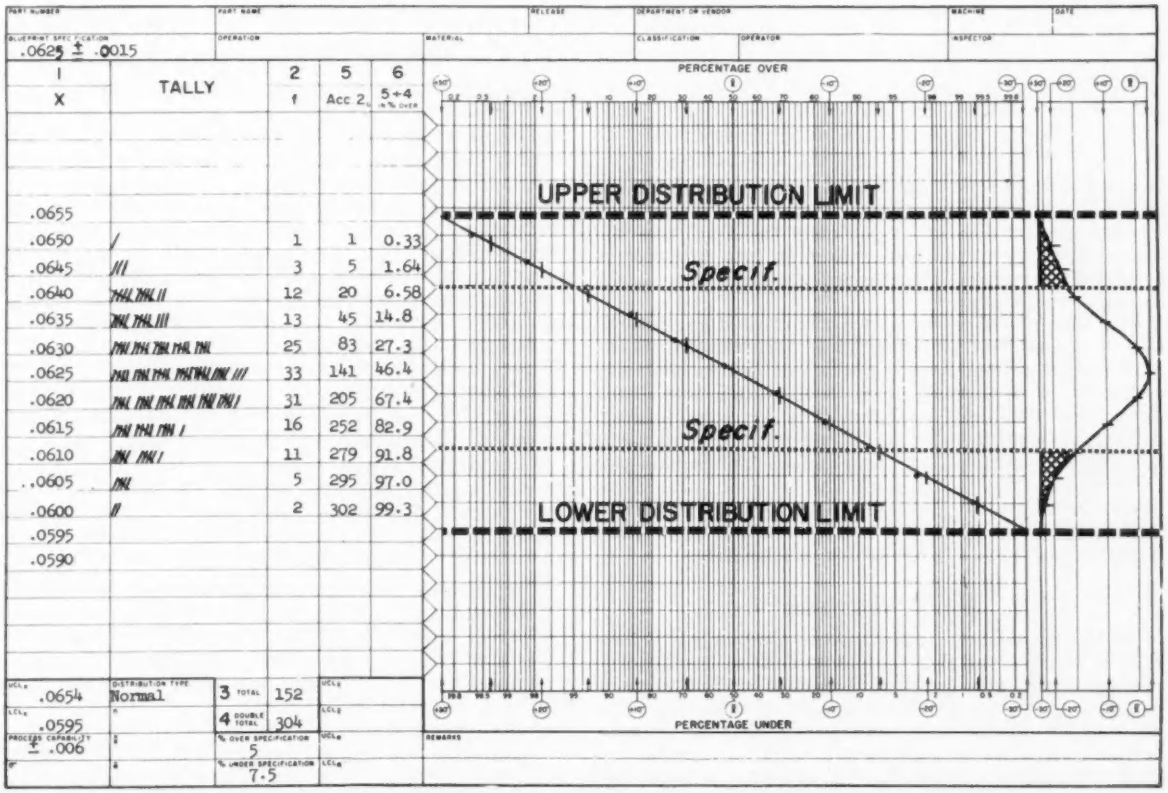


Fig. 3—With the aid of a frequency distribution analysis sheet the percentages of over and under specifications material can be estimated with a reasonable degree of accuracy as the shaded areas indicate.

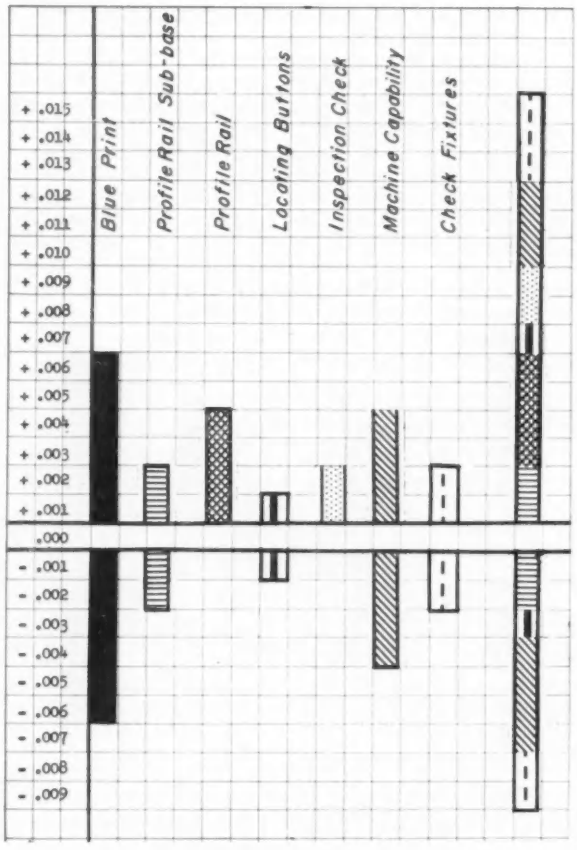


Fig. 4—Effect of the addition of individual tolerances.

reconsider the tolerances were denied. A quality control survey of the tooling tolerance accumulation on the machine used to cut only the final overall dimension was undertaken and it was discovered that the extreme tolerances were + 0.015 and – 0.009 in., as shown in Fig. 4.

This bar chart represents accumulated tolerances only. It does not consider such variables as material, operator proficiency, and other machining operations accomplished prior to the final operation. After the practical ramifications of accumulated tolerances were brought to the attention of the engineering department, the original tolerance was reviewed. It was decided on the basis of the data available to modify the existing tolerance and now virtually all the parts are being accepted upon first presentation to the inspection department.

Stock Variations

The next problem appears to be simple, but is one that is being constantly encountered by the quality control engineer. In most industries it is standard practice to omit the overall thickness dimension for plate stock on the face of the drawing. The material call out column carries this requirement, which in this instance was for the use of ¼-in. plate stock.

The drawing indicated a step cut of 0.125 in. depth and the title block tolerance for three decimal figures of ± 0.010 in. is applicable to this dimension. To this point nothing appeared to be wrong. When consulting the material review record, however, it was evident that a high percentage of parts inspected were found to be over and under the blueprint tolerance. An immediate investigation was started.

The parts were machined with a hydraulic attachment and follower pattern with a normal expected accuracy of approximately ± 0.002 in. A frequency distribution was made on the next available release of parts by measuring the step depth. The results are shown in Fig. 5.

From this distribution it is apparent why so many parts were rejected by the inspector. The next question was, "What was the repeatability of the machine, or better, what was the machine capability?" The remaining step thickness was measured and a frequency distribution was compiled with the results as indicated in Fig. 6. This distribution indicated that the answer was to be found in something other than the repeatability of the machine. After comparing these two distributions, it became apparent that the material was the contributing factor in the excessive variation. (See Fig. 7.)

Here, then was the cause for the high percentage of rejections. The total stock tolerance was 0.026 in. while the part tolerance was only 0.020 in. The number of parts accepted or rejected was, in effect, dependent upon the thickness of the setup part. That is, if the thickness of the setup part was on the heavy side, a substantial percentage of the parts would have a shallow step cut when the machine was held constant, and vice versa, a thin setup part would give a deep step cut.

For each part to be made correct under these conditions, it would be necessary for the machine operator to make a trial cut on the part, measure it for depth, raise the table the necessary amount to meet the tolerance requirements, and make the final cut.

This would result in a part by part manufacturing operation and is certainly not conducive to a high production rate. The original dimensioning of this part was probably the direct result of the sheet metal dimensioning and its rule of always keeping the dimensions to the same side of the sheet. This practice is acceptable for sheet metal, but cannot be made applicable to machined parts. In modern airplanes, however, we find the conventional sheet metal parts giving way to machined parts and it is causing the engineer to modify his thinking from sheet stock tolerances and practices to plate stock.

What should the engineer have considered when designing this part? To answer the question, it is believed the engineer should have considered the following points to eliminate this condition, which contributed to unnecessary cost:

1. The method of manufacture should have been considered by the designer. Since no tooling holes were provided, the part had to be located from the lower side of the plate. Therefore, the plate tolerance could fluctuate in only one direction.
2. The stock tolerance should have been compared to the desired part tolerance.
3. The importance of the step cut should have been determined. If it was desirable for the step cut to be held to the ± 0.010 in., the de-

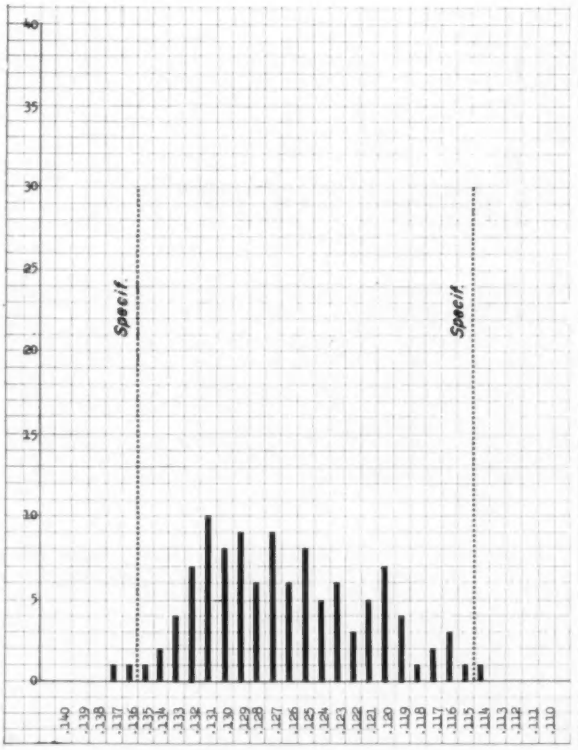


Fig. 5—Frequency distribution of a lot of parts made by measuring the step depth of the piece. The shape of the piece is shown in Fig. 7. Specifications called for a dimension of 0.125 ± 0.010 in.

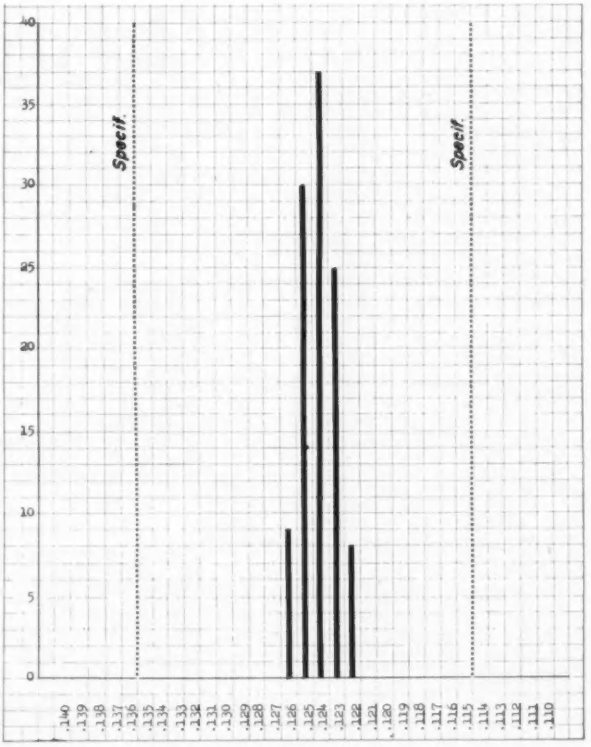


Fig. 6—A frequency distribution of the same part using the remaining step thickness as the measurement.

signer should have dimensioned the overall thickness on the drawing face with a tolerance close enough to assure the step depth. This would require an added operation in the shop but would result in an acceptable part at a lesser cost than when material review disposition is required. If the step depth is not critical the designer can dimension the remaining step thickness with title block tolerance or give a step depth tolerance to agree with the stock tolerance—in this case ± 0.013 in.

Initially, the second alternative for noncritical step depth appears to be a satisfactory answer. This decision, however, does not stand up when reviewed for production requirements since such a choice would require the operator to measure the part thickness until he found one at or near the blueprint basic in order to establish the machine setting. Unless this is done, the original condition of parts being out of specification could result.

The use of the laws of probability in establishing tolerances requires that the quality control engineer be familiar with the methods involved, and confident of the advantages of such a technique. He should act as a middle man and view the situation with objectivity. Careful analysis of the problem, selection and preparation of exact data, and a logical presentation to both the design engineer and the production supervision is of vital importance. By so doing, the quality control engineer is aiding in the solution of specific problems and is also contributing to the state of the art by introducing new tools to all concerned.

This paper will be available (in multilith form), as part of a panel discussion along with 6 other panel discussions, by June 30. Write SAE Special Publications and ask for SP-315. Price: $1.50 to members, $3.00 to nonmembers.

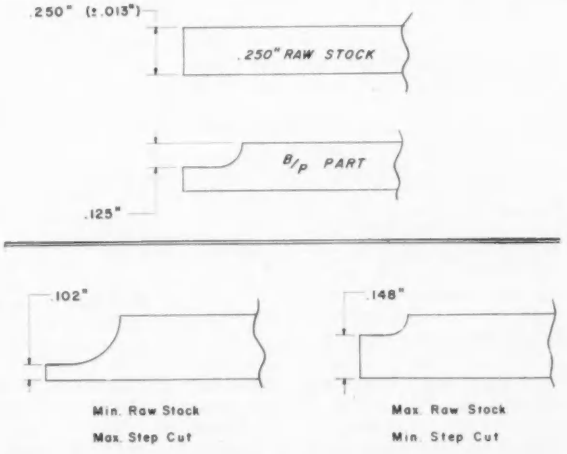


Fig. 7—Stock tolerance must be taken into consideration when assigning tolerances to a cutting operation. Notice the possible variation in step cut with variation in stock size.

About SAE Members

Glidewell Szady Zoellner MacKenzie

J. E. GLIDEWELL, vice-president, Engineering, Hall-Scott Motors Co., was featured as guest speaker before the Berkeley Exchange Club, Berkeley, Calif. He provided the club with "A Brief History of Hall-Scott Motors Co."

Hall-Scott, organized in 1909 by B. C. Scott and E. J. Hall for the purpose of building motor cars for use on rails, now has two Divisions. The Hall-Scott Engine Division is located in Berkeley. The Hall-Scott Electronics Division has recently been organized in Burbank.

L. T. SZADY has been elected vice-president in charge of engineering for Formsprag Co., Van Dyke, Mich. He has been associated with Formsprag as a design engineer since 1946, and chief engineer since 1950.

He is a member of the Engineering Society of Detroit, the Michigan Society of Professional Engineers, and the American Ordnance Association.

ROBERT E. ZOELLNER has been appointed Detroit automotive zone manager within the Central Sales Region of New Departure Division, GMC.

Zoellner, affiliated with GMC for the past 11 years, has been with its New Departure Division as an automotive engineer with headquarters in Detroit since Nov., 1948.

He has been active on SAE Detroit Section's Reception and Membership Committees.

RUSSELL E. MacKENZIE has been appointed executive engineer for the automotive products section of Bendix Products Division, Bendix Aviation Corp. He has been chief truck engineer of Studebaker-Packard Corp. during the past seven years.

In his new post, MacKenzie will be particularly active on new product development.

E. VAN VECHTEN has been appointed manager of airline sales of Air Logistics Corp., according to an announcement by **J. F. SCHIRTZINGER**, president of the corporation.

In his new capacity Van Vechten will concentrate on commercial airline adaptations of Air Logistics' military ground support systems, and in addition will work on several new developments for the ground support of jet and turbo-prop airliners. He has been manager, Keystone Products, Keystone Engineering Co.

CARSON O. DONLEY, 1955–1956 Indiana Section chairman, has been transferred by GMC to its Diesel Equipment Division, Grand Rapids, Mich. He will serve the Diesel Equipment Division as chief engineer.

He has been chief engineer in the Bearing Department, Allison Division, Indianapolis.

The move forced Donley to resign as Section chairman. His services to Indiana Section also included functioning as Meetings chairman in 1953–1954.

Vice-Chairman Stuart Wilder will serve as Section chairman for the remainder of the year.

WILLIAM A. M. BURDEN has been elected to the board of directors of Lockheed Aircraft Corp., as announced by **ROBERT E. GROSS**, chairman and president of Lockheed.

Burden is senior partner of William A. M. Burden and Co., New York Investment Co. specializing in oil and mining properties. He is also a director of Hanover Bank of New York, Cerro de Pasco Corp., Union Oil and Gas Co. of Louisiana, and the American Metal Co., Ltd.

He is a member of the National Advisory Committee for Aeronautics, the Institute of the Aeronautical Sciences Council, of which he was president, the American Rocket Society, and the Royal Aeronautical Society. He is also president of the Museum of Modern Art, New York, of the Foreign Service Educational Foundation, the Parsons School of Design, and the French Institute in the U. S. He is a director of the Council on Foreign Relations and an officer of the Legion of Honor of France.

DAVID M. BALDWIN has been named executive secretary of the Institute of Traffic Engineers. His headquarters will be in Washington, D. C.

Baldwin formerly was director of the Traffic and Transportation Division of the National Safety Council. Prior to that connection, he was associated with motor vehicle administration in the State of Virginia.

He currently is a member of the SAE Motor Vehicle Seat Belt Committee.

STEPHEN J. TOMPKINS has become chief engineer, Truck Operations, for Chrysler Corp. Dodge Division. He had formerly been chief engineer, Truck Design and Development, for Chrysler Truck Division.

Tompkins was meetings vice-chairman for the SAE Truck and Bus Activity Committee in 1955. He was Detroit Section vice-chairman (Truck and Bus) in 1954. He is currently serving on the SAE Truck and Bus Activity Committee.

DON R. MITCHELL, president and general manager, Ionia Mfg. Co., Mitchell-Bentley Corp., received a tribute in the Sunday, March 11 edition of *Detroit Free Press*.

The story portrays the rise of a man from a youth in 1920 asking for a loan from Owosso Savings Bank to a director of that bank. It also portrays the growth of a collapsing furniture company in 1938 to a two-plant number one producer of station wagon bodies in 1956.

JOHN W. THORP, formerly airplane project engineer with Fletcher Aviation Corp., is now an aviation consultant with Air Logistics Corp., Pasadena, Calif., and Hiller Helicopters, Inc., Palo Alto, Calif.

EUGENE M. LANG, president of Resources and Facilities Corp., is serving on a trade mission to France. He was selected for the service by the United States Government.

The mission was constituted under the program inaugurated in 1955 by President Eisenhower to foster trade and technological cooperation between American and foreign industry.

Lang has specialized in negotiating and administering international license agreements and in furnishing related technical and marketing aid.

WILLIAM E. LIND, formerly vice-president and general manager, ARA Mfg. Co., is now manager, Cab, Bus and Refrigerated Transport Division, Frigikar Corp. He is in charge of design, sale, and distribution of truck cab and bus air conditioning units and refrigerated transport systems.

Lind was SAE Texas Section chairman in 1945-1946. He is presently a member of the Section Governing Board.

HERBERT BEVANS is now serving at Chrysler Proving Grounds, Chelsea, Mich., as chief engineer, vehicle testing, Chrysler Engineering Division. He has been a resident engineer in the Chrysler Indianapolis plant.

R. A. PENLENER has been appointed as an assistant sales manager of automotive products for A. O. Smith Corp. He has been in charge of truck frame engineering as it is related to customer service.

Lind

Bevans

Penlener

Mikita

Oliver

Pruyn

Bell

Simons

WILLIAM E. OLIVER has been recalled to Detroit to serve as a contact engineer for Dodge Division, Chrysler Corp. He has been serving as engineer for defense with the Chrysler Engineering Division.

WALTER VAN NESS PRUYN is now on leave from his position as director, Spring Garden Institute, Automotive Training Center, Philadelphia, to visit Turkey as a consultant for U. S. International Cooperation Administration sponsored Spring Garden Institute Automotive Maintenance Training Mission. He is serving as program chief for the Mission.

The project is to set up a system of automotive vocational and technical schools throughout Turkey, under the Ministry of Education, with four technical centers similar to Spring Garden Institute Automotive Training Center at Izmir, Ankara, Istanbul, and Adana. Ten supporting vocational institutes are to be set up to provide training in the basic phases of automotive maintenance.

CHARLES R. BELL has joined the Rocketdyne Division, North American Aviation, Inc., in the position of senior research engineer. He will be concerned with studies and evaluation of weapons systems as well as research and design proposals.

Bell had been a research engineer with Armour Research Foundation of Illinois Institute of Technology.

H. CHARLES SIMONS, chief engineer of Eaton Mfg. Co.'s Heater Division since 1948, has been promoted to sales manager of Heater.

Simons has been a member of SAE Cleveland Section's Governing Board for the past three years. He is serving as 1955–1956 Placement Committee chairman for the Section.

JACK F. WOLFRAM, general manager of Oldsmobile Division and vice-president of GMC, has been honored by the Grand Valley Chapter of the Michigan Society of Professional Engineers for outstanding contributions to the field of engineering. He received the award, the first made by the Society, at recent ceremonies in Lansing, Mich.

ADRIAN E. DIBLE has been appointed chairman of the Automotive and Mobile Equipment Committee, American Gas Association. He is superintendent of automotive equipment at Equitable Gas Co.

Dible is 1955-1956 treasurer of SAE Pittsburgh Section.

J. J. MIKITA has been named sales manager of the new additives group of du Pont's Petroleum Chemical Division. He will continue to hold headquarters in Wilmington, Del.

He has been director of the du Pont Petroleum Laboratory.

Mikita has been a member of the SAE Membership Committee in 1955–1956 and also a member of the Fuels and Lubricants Activity Committee since 1954.

W. E. BETTONEY, formerly an assistant director of the Petroleum Laboratory, will become manager for additives in the Eastern region with headquarters in New York.

N. D. LAWSON, who has been head of the fuels and lubricants section of the laboratory, will take over as manager for additives in the Central region, working out of Chicago.

J. B. MALIN has been named to the new position of manager of additives in the Western region where he has been regional laboratory manager.

DR. B. M. STURGIS, formerly assistant director, has been promoted to director of the Petroleum Laboratory. **R. H. BLAKER** will be one of his assistant laboratory directors. He will handle product evaluation. Blaker has been a division head in the laboratory.

Six other SAE members have new positions with du Pont's Petroleum Chemicals Division.

E. B. EIPPER, formerly superintendent of laboratory service, is now a laboratory engineer.

J. R. GRIFFIN has become division head—Lube Oil. He has been an automotive technologist.

KENT HYATT, who has been a technical representative, has become group supervisor—field.

A. O. MELBY, who was group leader —scavenging, is now division head—Gasoline.

J. D. ROGERS, a development engineer, has become supervisor—jet fuel.

K. C. EDSON is now a technical representative—field group. He has been serving as a technical representative.

RICHARD L. GATES has become a senior project engineer with Thompson Products, Inc., as a member of Staff Research and Development. He has been serving as a project engineer for the company.

ALBERT H. BEAUFRERE, formerly manager of the Gas Turbine Department of Ford Motor Co., is now president of Turbodynamics Corp., Huntington, N. Y. As well as acting as chief executive of the company, he will consult on gas turbine power plants and other turbomachinery, and supervise design projects involving gas turbines, superchargers, and pumps.

Janeway

ROBERT N. JANEWAY, originator of the Janeway combustion chamber and leading specialist for the past 25 years on suspension engineering for the automotive, railroad, and other fields, has resigned as assistant chief engineer of the Chrysler Corp. in charge of dynamics-research, to form Janeway Engineering Co. in the Machinery Building, Detroit.

Janeway's debut in industry after graduation from Cornell University was with General Motors Research, where he worked closely with Thomas Midgeley, discoverer of tetra ethyl lead. It was this work which led him into combustion chamber development.

Resigning from GM, he joined Chrysler Corp. in 1931 and participated actively in the development of "floating power" for Plymouth. He established the now generally accepted "center of percussion" theory of automotive suspension for vehicles which was first embodied in the De Soto and Chrysler Airflow cars. Since then the principle has led to the characteristic front body overhang of the modern automobile.

In 1953 he organized and was appointed head of Dynamics Research at Chrysler. Working closely with a group of leading railroads, he supervised the development of a new under-carriage (truck) for freight cars and later a similar unit for railroad passenger cars. The latter is not yet commercially available, but is being marketed.

Janeway has been a pioneer in the application of analog computers to the solution of complex suspension problems and is also responsible for the establishment of the now widely accepted limits of vibration which the human being can stand without discomfort.

He has been active in SAE, serving in the past as chairman of the Detroit Section and on several national committees. He was 1954–1955 chairman of the SAE Riding Comfort Research Committee. He has also served as consultant to the National Resources Planning Board and to President Eisenhower's Cabinet Committee on Transportation.

While specializing in suspension design and development, Janeway Engineering Co. plans to encompass all areas of applied dynamics.

Somebody Told Me

by R. L. Hackett

The big question is how does **JIM MORROW**, metallurgical engineer for Steel Co. of Canada, Ltd., and President of Canadian Standards Association, keep the geese, ducks, black angus, chickens, sheep, and goats unscrambled on his farm near Hamilton, Ont. Incidentally, did you know that years and years ago, maybe 30, **JIM** took a portable lab up into the now fabulous Labrador region and assayed the ore?

STM

WAYNE WORTHINGTON'S company Christmas gift was a 25-year continuous service pin from Deere & Co., and its subsidiary, John Deere Waterloo Tractor Works. Wayne is President of the American Society of Agricultural Engineers this year, too. Congratulations, WAYNE.

STM

EARLE SMITH, chief metallurgist of Republic Steel rated a **"SALUTE"** February 2 in Iron Age. Part honors include ASM gold medal; Lamme Medal, Ohio State University; Institute Medal, AISI. Letters in football and track from O.S.U.

STM

T & M Veep **JUDY GAUSSION** told everyone that that patch over his eye brow was from getting caught in a revolving door at the Sheraton-Cadillac Hotel during Annual Meeting.

STM

Nominees for an SAE Skiing Team are **PAUL ACKERMAN** Chrysler dir. of engrg., and assistant general manager, Auto Division, Timken Roller Bearing Co. **BOB WINGERTER.** Any other candidates?

STM

Emeritus Draftee **BILL SILER** who retired from Delco-Remy Division in March, 1955 was drafted by acclamation as 1956 chairman of SAE Automotive Drafting Standards Committee. **BILL** got a good Vice-Chairman, **CHARLIE WRIGHT**, Chrysler Corp., so he can travel between meetings.

STM

WM. CLAY "BILL" FORD, Junior Chamber of Commerce's "Outstanding Young Man of 1955" couldn't be present to accept honor. Foot in cast from snapped tendon playing paddle tennis, a mighty tough game. Incidentally, **BILL** was captain of Yale tennis team. Coaches said he could have gone places, but Thunderbirds and Continentals interfered.

Prominent SAE Engineers Given University of Missouri Awards

SAE President George A. Delaney (left) receives Missouri Honor Award from Dean Huber Croft, University of Missouri College of Engineering.

Louis H. Winkler (left), Bethlehem Steel Co., is presented the bronze award by Dean Croft.

GEORGE A. DELANEY, 1956 SAE president, and **LOUIS H. WINKLER**, Bethlehem Steel Co., were presented with Missouri Honor Awards for Distinguished Service in Engineering by Dean Huber Croft of the University of Missouri College of Engineering.

The citations addressed to Delaney and Winkler read as follows:

"GEORGE A. DELANEY, in formal acknowledgement of his distinguished career in the science of automotive engineering;

His technical leadership as chief engineer of the Pontiac Motor Division of General Motors Corporation;

His productive service in the field of standardization as director of the American Standards Association;

His professional leadership as former chairman of the Technical Board of the Society of Automotive Engineers, and now, as the current president of this society;

The College of Engineering and Engineering Foundation of the University of Missouri proudly confer upon this alumnus the Missouri Award for Distinguished Service in Engineering."

"LOUIS HARRY WINKLER, in recognition of his outstanding achievements in the fields of metallurgical engineering and steel manufacture;

His leadership in the development of technical codes for the design, manufacture, and testing of steel rails, locomotive forgings, wire rope, wire and

continued

wire rods, and tubular products;

His high ability to understand his fellow man, to provide effective and responsible technical leadership in the steel manufacturing industry;

The College of Engineering and the Engineering Foundation of the University of Missouri confer upon this alumnus the Missouri Honor Award for Distinguished Service in Engineering."

SAE Past-President **JAMES M. CRAWFORD**, secretary of the La Jolla Art Center, recently received an honorable mention award for his oil painting, "San Diego Bay." He is a frequent contributor to the La Jolla art exhibits. He is also an exhibitor at the San Diego Memorial Art Institute.

Besides being re-elected secretary of La Jolla Art Center, Crawford has been appointed chairman of the By-Laws Committee and chairman of the Membership Exhibit Committee.

He was SAE president in 1945.

MUNDY I. PEALE, president, Republic Aviation Corp.; **ALEXANDER KARTVELI**, Republic vice-president and chief engineer; and **WILLIAM I. STIEGLITZ**, Republic design safety engineer, have been reappointed for 1956 to serve on committees of the National Advisory Committee for Aeronautics.

Peale will serve on NACA's industry consulting committee. The others wer appointed to committees investigating various aspects of aerodynamics, control, structural materials, power plants, and other areas of aeronautical study.

Stieglitz will also serve as an instructor in a college graduate course in aircraft safety at C. W. Post College of Long Island University. The course, entitled "Designing Aircraft for Safety," will last 15 weeks. It is being given in honor of Rear Admiral Luis de Florez, a designer of flight training devices and president of the Flight Safety Foundation, and is offered, along with another course on "Human Factors in Equipment Design," under the auspices of the foundation and the Cornell-Guggenheim Aviation Safety Center.

KENNETH R. HERMAN, president, Vickers, Inc., has been elected first vice-president of the Engineering Society of Detroit. He has been serving as second vice-president for the Society.

WILLIAM H. GRAVES, vice-president of engineering, Studebaker-Packard Corp., has become second vice-president to replace Herman. He has been ESD secretary.

FRED J. WALLS, in charge of Detroit technical section, International Nickel Co., replaces Graves as ESD secretary. He has been treasurer.

LOUIS W. SCHROEDER has become chief draftsman for Kenworth Motor Truck Co., Division of Pacific Car & Foundry Co. He has been in engine chassis design for the division.

Schroeder, an active member of the SAE Northwest Section, served on the Section Membership Committee in 1954–1955 and has been chairman of the Section Placement Committee in 1955–1956.

THEODORE J. SCHWEITZER, who has been assistant professor of mechanical engineering at the University of Wisconsin, has joined Douglas Aircraft Co., Santa Monica, Calif. as a design engineer.

Schweitzer has been faculty adviser for the SAE Student Branch at the University of Wisconsin.

HENRY T. NAGY, formerly quality control manager of Thompson Products, Inc., is now chief engineer with Trayer Products, Inc., Elmira, N. Y.

JAMES P. HUNSAKER, is now associated with Arthur D. Little, Inc., Cambridge, Mass. as a mechanical engineer. He has been serving in the same position with Jackson and Moreland, Boston.

DR. EDWARD R. SHARP, director of the Lewis Flight Propulsion Laboratory of the National Advisory Committee for Aeronautics, has been elected president of the Institute of the Aeronautical Sciences.

WILLIAM B. BERGEN, executive vice-president of Glenn L. Martin Co., was elected a vice-president of the Institute at the same time.

For treasurer, the Institute's Council chose **SHERMAN M. FAIRCHILD**, chairman of the board of Fairchild Camera and Instrument Corp. and a director of Fairchild Engine and Airplane Corp.

DONALD I. HALL, previously with Chevrolet Motor Division, GMC, in Tonawanda, N. Y., as a quality engineer, is now a development engineer with Moog Valve Corp. in East Aurora, N. Y.

ROBERT G. HARDIN has become sales engineer with Philadelphia Sales Division of Gulf Oil Corp. He has been junior mechanical engineer in the Gulf Refinery Technology Laboratory.

WARREN C. MacFARLANE, president and general manager of the Minneapolis-Moline Co., has become a Fellow of the American Society of Mechanical Engineers. The rank, one of the highest conferred by the Society, was given in recognition of Dr. MacFarlane's achievements in the engineering and production of farm machinery, including tractors, stationary engines, threshers, and tillage tools.

RUDOLPH GRAUPE, Fairchild Engine Division, Fairchild Engine and Airplane Corp., has been elected secretary of the New York chapter of the American Rocket Society.

S. HOWARD LAGERVELD, formerly with Titeflex, Inc. as chief draftsman, has joined the research division of Curtiss-Wright Corp. in the position of project engineer.

BRACE H. SIBLEY has been named vice-president of Champion Spark Plug Co. He has been factories manager for the company. His new responsibilities will continue to include overseeing the operations of all Champion assembly plants in the United States and abroad.

R. C. TEASEL, formerly research engineer, has been promoted to director of research for the company. He has been a research engineer with the company since 1949.

K. T. KELLER, chairman of the board of Chrysler Corp., has announced that he will discontinue participating in the active management of the company when his five-year term as chairman expires in April. His relations with the company will be as a consultant. He will not be a candidate for reelection.

On April 1, Keller will have completed 30 years in the management of Chrysler Corp.

STANLEY L. LUNDSTEN is now Detroit representative for the Richardson Co. He has been Detroit branch manager for Spaulding Fibre Co., Inc.

RICHARD GLEN RUFFE is now in missile test engineering with Convair Division, General Dynamics Corp. He has been a project engineer with Ford Motor Co.

RICHARD D. SAMPSON is now a design engineer with Aerojet-General Corp., concerned chiefly with rocket accessory power packs. He had been a project engineer with Jack & Heintz, Inc.

CHARLES J. MIDDLETON, formerly industrial engineer with Butler Mfg. Co., Galesburg, Ill., is now a manufacturing engineer with Convair Division, General Dynamics Corp.

CALVIN K. MILLER, who has been a development engineer with Chrysler Corp., has joined Soss Mfg. Co. as chief research and experimental engineer.

MARSHALL D. McCUEN has moved to the Allison Division, GMC, to serve as liaison for the Advanced Design and Development Section of the Aircraft Engine Engineering Department.

He has been with the Oldsmobile Division as a manufacturing superintendent.

DALE KELLY, until recently a mechanical engineer with Southwest Research Institute, has opened a testing and consulting practice for operators of automotive and mechanical equipment. He will continue to make his headquarters in San Antonio, Texas.

Kelly has worked as an experimental engineer with Mack Mfg. Corp. and has been an assistant professor of mechanical engineering at Lehigh University. He has served as Student chairman of the Philadelphia Section and the South Texas Division of the Texas Gulf Coast Section.

FRED J. SCHMIDT is now vice-president of Pfarrer-Schmidt Engineering, Inc., Chicago, Ill. He had been chief engineer of American Steel Dredge Co., Inc., Fort Wayne, Ind.

KENNETH M. SILCOCK is now assistant chief engineer with Thompson Products, Inc. He has been an assistant development engineer with Nash Motors Division of American Motors Corp.

CHARLES H. SKUZA has joined the South Haven Rubber Co., South Haven, Mich., in the position of vice-president and technical director.

Skuza has been chief chemist with Phoenix Mfg. Co., Joliet, Ill.

B. W. BOGAN, chief engineer for Dodge Division, Chrysler Corp., since 1950, has been named to the newly created post of executive engineer of the Dodge Division.

In his new position, Bogan has responsibility for all car and truck engineering activities of the Division.

DR. WILLIAM F. BALLHAUS, chief engineer, Northrop Aircraft, Inc., has been appointed to head the committee on aircraft construction of the National Advisory Committee for Aeronautics. He served on the committee during 1955.

RALPH S. DAMON, who was president of Trans World Airlines at the time of his death, Jan. 4, 1956, was named the American honorary fellow for 1955 by the Institute of Aeronautical Sciences. The posthumous award of the Institute's highest honor recognized Damon's lifetime career in aviation and his interest in the IAS.

WILLIAM B. BERGEN, executive vice-president of Glenn L. Martin Co., was named a fellow for 1955.

Fellows of the Institute are chosen on the basis of having "attained a position of distinction in aeronautics and made notable and valuable contributions in one of the aeronautical sciences or aeronautical engineering." Honorary fellows must be "persons of eminence in aeronautics."

Eleanor Allen

Frances Weeden

ELEANOR ALLEN has been named editor of SAE Transactions. She has been managing editor since 1946 and technical editor of SAE Journal since 1942.

FRANCES WEEDEN has been named managing editor of SAE Journal, following nine years as technical editor. She succeeds Joseph Gilbert who has become manager, Technical Committee Division. (See March, 1956, issue, SAE Journal, page 81.)

THOMAS HARRIS (Purdue University '56) has joined Cities Service Oil Co., Bartlesville, Okla., where he will serve in the Industrial Relations Department.

JAMES G. GREINER (Pennsylvania State University '56) is now serving with New Holland Machine Co., New Holland, Pa., as an engineering trainee.

New Holland Machine Co. is a subsidiary of Sperry Rand Corp.

JAMES E. McDOWELL (Pennsylvania State University '56) is now associated with Rem-Cru Titanium, Inc., Midland, Pa. He is serving in the position of junior research engineer.

JAMES R. DAVIDSON (University of Miami '56) has joined Westinghouse Electric Corp. Atomic Power Division as a quality control engineer.

CHARLES L. RUTSCHMAN (Agricultural and Mechanical College of Texas '56) has taken the position of junior engineer with Temco Aircraft Corp., Dallas, Texas.

HAROLD A. STRICKLAND, JR. has joined General Electric Co., New York City, as a consultant—energy ultilization, engineering services. He had formerly served as vice-president of engineering with Hotpoint Company Division, General Electric Co., Chicago.

Correction

In a picture caption on page 79 of the March issue, SAE Journal erroneously stated that **Harold V. Nutt,** new head of the Naval Engineering Experimental Station's Internal Combustion Engine Laboratory, "was SAE vice-president representing Passenger Car Activity in 1954."

The holder of that position was **Harold Nutt,** president and general manager, Borg & Beck Division, Borg-Warner Corp.

RALPH BAYLESS, chief engineer in the San Diego Convair Division plant, General Dynamics Corp., and **J. H. FAMME,** an assistant chief engineer in the same plant, were honored with 20-year emblems in February. They joined the company within a few days of each other during January of 1936.

JOHN BONFIELD is now working as a mechanical design engineer with Dillworth, Secord and Associates, Ltd., consulting mechanical engineers in Montreal. He had been an assistant engineer with Fruehauf Trailer Co. of Canada, Ltd.

G. DUANE SHAW is now associated with Rucker Co., Oakland, Calif. He had been a project engineer with Pacific Car & Foundry Co., Renton, Wash.

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Obituaries

FREDERICK W. HEISLEY

Frederick W. Heisley, vice-president, Allied Wheel Products, Inc. and Wheel and Rim Sales Co., died Dec. 21, 1955.

He had been with Allied, and Wheel and Rim, since 1945. For 20 years previous to that he served Joseph Woodwell Co., Pittsburgh, as manager of the Wheel and Brake Department.

Heisley was a graduate from Cornell University in Mechanical Engineering. He was a member of Tau Beta Pi, college engineering fraternity, and a Junior Member of the Engineers' Society of Western Pennsylvania.

He served SAE Pittsburgh Section as chairman in 1935–1936. Previously he held the posts of vice-chairman in 1934–1935; secretary in 1933–1934; and chairman of the Program Committee in 1932–1933.

JOHN A. ALEXANDER

John A. Alexander, vice-president of Alexander-Seewald Co., died Dec. 3, 1955. He started with the company in 1919.

At that time he joined his father, founder of the company, and his brothers doing allround work during school vacations. Positions he has held with the company since that beginning include traveling salesman, manager of branch office he opened in Jacksonville, secretary, purchasing agent, and vice-president.

He was also vice-president of Alexander Industrial Co.

He was a member of the Motor and Equipment Wholesalers Association in Chicago.

JOHN A. CARNIE

John A. Carnie, a project engineer with Dodge Truck Division, Chrysler Corp., died Nov. 5, 1955. He had been a member of SAE since 1928.

Carnie attended Hamilton Institute, General Motors Institute, and the University of Detroit.

He started in industry in 1924 as a detailer for Detroit Machine Tool Co. Between then and joining Dodge Truck Division, Carnie served in various positions for the following companies: Federal Mogul Corp., Studebaker Corp., American Car & Foundry Co., Buick Motor Division, Evans Products, Inc., and Detroit Timken Axle Co.

WALTER TREFZ

Walter Trefz, technical service director for the Micro-Lube Sales Co., died Nov. 5, 1955.

He started his career as a field service representative for Cleveland Tractor Co. St. Louis branch in 1919. He then served in the same position with Gill Piston Ring Co., H & H Machine Co., and Hinkley Motors, Inc. In 1922 he returned to H & H Machine Co. to serve as parts manager and then engineer until 1929.

From then until he joined Micro-Lube Sales, Trefz served with Industrial Equipment Department, Climax-Jones & Quinn, Inc.; Aluminum Industries, Inc.; National Standard Parts Association; and Southwestern Warehouse Distributors, Inc.

He had at one time been a member of the Automotive Engine Rebuilders Association.

BEN F. HOPKINS

Ben F. Hopkins, retired chairman of the board of Cleveland Graphite Bronze Co., died Dec. 26, 1955. He was a

CONTINUED ON PAGE 118

News of SAE

Wentworth and Daniel Share SAE Horning Award

Wentworth

Daniel

JOSEPH T. WENTWORTH and WAYNE A. DANIEL, research engineers in the Fuel and Lubricants Department of General Motors Corp. Research Staff, have been named to receive the SAE Annual Horning Memorial Award on June 4, 1956, during the SAE Summer Meeting in Atlantic City, N. J. They are being honored for authorship of a technical paper entitled "Flame Photographs of Light Load Combustion Point the Way to Reduction of Hydrocarbons in Exhaust Gas," which was presented at the 1955 SAE Annual Meeting in Detroit, Jan. 10, 1955. This paper was judged by the Horning Medal Board of Award as the best new contribution to existing knowledge in the art of mutual fuel and engine adaptation that was presented at a meeting of the Society during 1955.

Wayne A. Daniel has been employed by GMC Research Staff since 1952. He was graduated with a B.S. in physics from the University of Texas in 1951.

Joseph T. Wentworth was graduated with a B.S. in mechanical engineering from the University of Michigan in February, 1952, and has been with GMC Research Staff since graduation. He received the 1955 Russell S. Springer Award for the youngest SAE member whose paper was published in the 1955 SAE Transactions.

In arriving at the Award decision, the Horning Memorial Award Board thought it particularly significant that these two young men put in a great deal of time outside their working hours to gather data for their paper, and had used the family car in their experiments. Since this was usual procedure back in the days when Harry L. Horning used to lend his encouragement to young research workers, the Board feels that presentation of the award to Wentworth and Daniel would have met with particular approval by Horning.

The Horning Award has been presented annually by the SAE since 1936 when it was established in memory of Harry L. Horning, a leader in the standardization of testing fuels and the mutual adaptation of fuels and engines.

C. J. Livingstone, chairman of the Horning Memorial Board of Award, will preside at the presentation ceremonies on the morning of June 4, in the Viking Theatre of the Chalfonte-Haddon Hall Hotel, Atlantic City, N. J.

You'll . . .

be interested to know that . . .

APPOINTMENT HAS BEEN MADE by President Delaney of **W. W. Schafer,** Lubrizol Corp., to complete the unexpired term of **J. J. Mikita** on the Membership Committee. The term extends to the close of the 1958 administrative year.

THE FOLLOWING APPOINTMENTS to Activity Committees have been made by the respective Vice-Presidents:

Aircraft Powerplant
—**H. J. Graham**
W. G. Nostrand

Passenger Car
—**J. S. Voigt**

Truck and Bus
—**G. Russell Noble**

D. ROY SHOULTS will serve as SAE representative on the Daniel Guggenheim Medal Board of Award to succeed **R. P. Kroon.** Kroon's term expires on Sept. 30, 1956. Shoults' appointment will be for a three-year term beginning Oct. 1, 1956.

Other SAE representatives now serving on the Board are **E. C. Wells** and **M. G. Beard.**

SAE will join the Institute of the Aeronautical Sciences in celebrating the 75th birthday of Dr. Theodore von Karman, IAS Honorary Fellow. **J. L. Atwood,** president, North American Aviation, Inc., will represent SAE at the official celebration during the IAS Summer Meeting Dinner in Los Angeles on June 20, 1956.

Lamb Heads Committee for Buckendale Lectures

ERNEST P. LAMB, new chairman of the L. Ray Buckendale Lectures Committee, has called his committee together to select a 1957 lecturer to recommend to the SAE Council.

Lamb was named chairman at the beginning of this year by SAE President George Delaney. Serving with Lamb are R. R. Burkhalter, C. A. Lindblom, E. F. Petsch, and M. A. Thorne.

It's the committee's duty to provide for "an annual lecture and monograph by a distinguished authority in the technical areas of commercial or military ground vehicles, directed toward filling the needs of young engineers and students for up-to-date practical knowledge." The man selected as Lecturer receives a cash award and a certificate.

First three men named Buckendale Lecturers were K. W. Gordon, C. G. A. Rosen, and William P. Michell.

L. Ray Buckendale, president of SAE in 1946, was for many years before his death in 1952 the guiding engineering light of Timken-Detroit Axle Co., now a Division of Rockwell Spring and Axle Co. This company provided the fund which made the Lectureship possible.

SAE National Summer Meeting

Chalfonte-Haddon Hall
Atlantic City, N. J.
June 3-8, 1956

A meeting of engineering minds for exchange of valuable information and experience, via round table discussions and 36 technical papers, including six symposiums.

6 Symposiums

There'll be a wealth of material on: Cavitation and Corrosion in Engine Cooling Jackets; Volatility; Status of Aluminum Radiators; Where Does All the Power Go; Latest Developments on Vehicle Retarders; and Emergency Braking Systems for Combinations of Commercial Motor Vehicles.

36 Technical Papers

You'll find important information about subjects such as: Human Factors of Crash Protection in Automobile; A Free Piston Diesel Engine; Research in the Fundamentals of Automobile Control and Stability; New Techniques of Automobile Frame Manufacture; and Fuel Anti-Knock Performance in High Compression Engines.

5 Round Table Discussions

Panels of specialists will lead informal gatherings: Developments in Seating; Industry Report on Automotive Safety Research; The Place of the Plastics Industry in Automobile Body Design and Construction; Operators' Experience with Truck Tubeless Tires; and Range and Splitter Ratios in Transmissions and Axles.

Special Events with A Polynesian Flavor

65 Papers Approved so Far for 1956 SAE Transactions

THE 1956 SAE Transactions is scheduled for publication in August. It will contain about 750 pages, and will be clothbound in maroon. It will include an author, title, and subject index covering all papers and their discussions contained in the volume.

So far, 65 papers have been approved by SAE Readers Committees for inclusion in this Transactions. Each of these papers will be printed in full, complete with written discussions of the papers. In some cases, the secretary's report of the oral discussion that took place after the presentation of the main paper is included.

Prices are: $3 to members, $7 to public and college libraries and U. S. Government agencies, $10 to nonmembers; foreign: $3 to members, $8 to public and college libraries, $11 to nonmembers.

The papers approved so far are:

Stop Sludge and Go Clean—by **R. H. Albrecht, R. I. Potter,** and **Kent Hyatt**

Creativity in Engineering—by **J. E. Arnold**

Wing Lift Augmentation Methods for the Improvement of the Low-Speed Performance of High-Speed Aircraft—by **J. S. Attinello**

Tire Design—Present and Future—by **L. L. Baldwin**

Passenger-Car Suspension Analysis—by **A. C. Bodeau, R. H. Bollinger,** and **L. Lipkin**

The Low Silhouette Drive Line—by **R. R. Burkhalter** and **P. J. Mazziotti**

Mechanical Octanes for Higher Efficiency—by **D. F. Caris, B. J. Mitchell, A. D. McDuffie,** and **F. A. Wyczalek**

The Napier Deltic Diesel Engine—by **Ernest Chatterton**

High Temperature Problems Associated with the Use of Rubber in Aircraft—by **F. E. Clark**

Fuel Vaporization and Ignition Lag in Diesel Combustion—by **M. M. El Wakil, P. S. Myers,** and **O. A. Uyehara**

The Interrelationship of Design, Lubrication, and Metallurgy in Cam and Tappett Performance—by **E. B. Etchells, R. F. Thomson, G. H. Robinson,** and **G. K. Malone**

Cold Starting with V. I. Improved Multigrade Oils—by **F. B. Fischl, H. H. Horowitz,** and **T. S. Tutwiler**

Some Experiments in the Application of Boundary Layer Control—by **Joseph Flatt**

A Billion Engine Hours on Aluminum Bearings—by **R. S. Frank** and **W. J. Lux**

Considerations Affecting the Life of Automotive Camshafts and Tappetts—by **M. F. Garwood, D. R. Kinker,** and **J. J. Manganello**

Fatigue and Its Relation to the Mechanical and Metallurgical Properties of Metal—by **G. R. Gohn**

Flexible Suspension Systems for Equipment in Transit—by **J. J. Goodill**

Practical Tire Research—by **V. E. Gough**

Design Factors in Automotive Safety—by **A. L. Haynes**

Some Elevated Temperature Structural Problems of High-Speed Aircraft—by **R. R. Heldenfels**

A Study of Non-Protective Rust Formation on Auto-Body Sheet Steel—by **J. C. Holzwarth, R. F. Thomson,** and **A. L. Boegehold**

The Supercharged Turboprop—by **S. G. Hooker**

Application of Metallic Materials for Aircraft Structures in the Temperature Range 600–1100 F—by **J. W. Huffman**

Diesel Smoke Measurement—by **H. C. Hunter**

Fuel Heat Gain and Release in Bomb Autoignition—by **R. W. Hurn, J. O. Chase, C. F. Ellis,** and **K. J. Hughes**

The Differential Gas Turbine—by **D. W. Hutchinson**

Automobile Body Loads—by **P. O. Johnson**

Tires for High Performance Cars—by **T. J. P. Joy, D. C. Hartley,** and **D. M. Turner**

The Knocking Behavior of Fuels and Engines—**R. V. Kerley** and **K. W. Thurston**

How High Should We Fly?—by **Schuyler Kleinhans**

Camshaft-Tappett Metallurgy in Ford Overhead Valve Engines—by **J. S. Laird, C. L. Stevens,** and **V. L. Iles**

Application of High Temperature Materials to Aircraft Powerplants in the Temperature Range of 1200–2400 F—by **A. V. Levy**

The Relationship of Low-Temperature Cranking to Viscosity Characteristics of Multigrade Engine Oils—by **G. K. Malone** and **T. W. Selby**

Fatigue and Fail-Safe Airframe Design—by **J. F. McBrearty**

The New Packard Torsion Level Suspension—by **F. R. McFarland**

Human and Environmental Factors of Automobile Safety—by **R. A. McFarland**

Human Factors in Highway Transport Safety—by **R. A. McFarland**

Human Problems in Jet Air Transportation—by **R. A. McFarland**

Evaluation of Reaction Kinetics Eliminates Diesel Knock—by **J. S. Meurer**

Automotive Gasoline Injection—by **S. E. Miller**

Shaft Gas Turbines for Helicopters—by **W. S. Miller, Jr., R. P. Krebs,** and **T. C. Blaschke**

A Radioactive Method for Measuring Engine Deposits—by **J. G. Mingle, H. W. Sigworth,** and **B. A. Fries**

Cushion Design from Fragility Rating—by **H. E. Nietsch**

Steels and Protective Treatments for Use Up to 1000 F—by **H. J. Noble** and **W. H. Sharp**

NACA Investigation of Thrust Reversal Techniques—by **J. H. Povolny** and **J. G. McArdle**

A New Approach to Turbojet and Ramjet Engine Control—by **W. E. Reed**

High-Speed Cornering Forces—by **J. J. Robson**

Mechanism of Engine Sludge Formation and Additives Action—by **D. T. Rogers, W. W. Rice,** and **F. L. Jonach**

A Practical Stopping Ability Regulation—by **C. C. Saal**

The New Packard V-8 Engine—by **W. E. Schwieder**

New and Improved Synthetic Elastomeric Materials for Automotive Use—by **W. J. Simpson**

Instrumentation for Valve Burning Studies—by **W. D. Sims**

Lightweight Springs for Limited Life—by **E. H. Spaulding**

Nitrogen Oxides, Combustion, and Engine Deposits—by **R. S. Spindt, C. L. Wolfe,** and **D. R. Stevens**

Effect of Rapid Load Changes on Torque Converter Performance—by **P. J. Swanson** and **J. H. Meier**

The Selection of Metals for Airframe Components as Affected by Operating at Elevated Temperatures Up to 600 F—by **M. Tiktinsky**

A Jet Exhaust Silencer—by **John Tyler** and **George Towle**

Operation of Passenger Tires at High Speeds—by **E. H. Wallace** and **S. A. Lippmann**

Farm Tractors and Their Tires—by **F. C. Walters** and **W. H. Worthington**

New Instrumentation for Engine Combustion Studies—by **J. A. Warren** and **J. B. Hinkamp**

Pneumatic and Sonic Measurement of Combustion Chamber Volume—by **G. A. Weinert**

The New Plymouth V-8 Engine—by **H. L. Welch**

Flight Research at High Altitudes and High Speeds with Rocket-Propelled Research Airplanes—by **W. C. Williams**

Principles and Applications of By-Pass Turbojet Engines—by **G. F. Wislicenus**

Physical and Chemical Ignition Delay in an Operating Diesel Engine Using the Hot-Motored Technique—by **T. C. Yu, R. N. Collins, K. Mahadevan, O. A. Uyehara,** and **P. S. Myers**

1956 SAE National Meetings . . .

June 3-8
Summer Meeting
Chalfonte-Haddon Hall
Atlantic City, N. J.

August 6-8
West Coast Meeting
Mark Hopkins Hotel,
San Francisco, Calif.

September 10-13
Tractor Meeting and
Production Forum
Hotel Schroeder, Milwaukee, Wis.

October 2-6
Aeronautic Meeting, Aircraft
Production Forum, and Aircraft
Engineering Display
Hotel Statler, Los Angeles, Calif.

October 10-12
Transportation Meeting
Hotel New Yorker
New York, New York

November 1-2
Diesel Engines
The Drake, Chicago, Ill.

November 8-9
Fuels and Lubricants Meeting
The Mayo, Tulsa, Okla.

1957

January 14-18
Annual Meeting and
Engineering Display
The Sheraton-Cadillac
and Statler Hotels,
Detroit, Michigan

March 5-7
Passenger Car, Body, and
Materials Meeting,
The Sheraton-Cadillac,
Detroit, Michigan

March 20-22
Production Meeting and
Forum, Hotel Statler,
Buffalo, New York

June 2-7
Summer Meeting
Chalfonte-Haddon Hall,
Atlantic City, New Jersey

TECHNICAL COMMITTEE *Progress*

Cockpit Standardization Committee Holds Two-Day Meeting in San Antonio

A VISIT to Kelly Air Force Base and a ride in a new Air Force transport equipped with turboprops gave members of SAE Committee S-7, Cockpit Standardization, a welcome respite in two otherwise solid days of deliberations.

The committee met March 27 and 28 in San Antonio, Texas.

Members considered suggestions on (1) instrumentation and cockpit control arrangement for electronic navigation and comunications aids, (2) circuit breaker and fuse arrangement, (3) cockpit controls for commercial aircraft, (4) cockpit visibility provisions, and (5) cockpit nomenclature, among other matters.

M. G. Beard of American Airlines, Chairman of SAE Committee S-7, with Major Gen. Brooke E. Allen (left) and Col. Claude W. Smith at Kelly Air Force Base.

1956 SAE Handbook Will Be Ready Soon

NEXT MONTH postmen will begin delivering 1956 SAE Handbooks to SAE members who indicated on their dues bills last fall that they wanted their copy at $1.

The new edition will contain 18 new reports and 77 revised reports, among its several hundred SAE Standards, SAE Recommended Practices, and SAE General Information Reports. The 1956 Handbook contains all current material approved for inclusion by the SAE Technical Board up to and including the Board's meeting in January of this year.

New reports include: Prevention of Corrosion of Metals, Grooved Straight Pins, Test Code for Small Stock Air-cooled Two-Stroke and Four-Stroke Cycle Gasoline Engines (6 hp and below), Passenger-Car Automatic Transmission Test Code, Commercial-Vehicle Disc Wheels, and Hydraulic Equipment Test Code.

Among the changes are: a new format for Screw Threads; addition of commercial designations to the section on aluminum; and, in the report on Starting Motor and Generator Curves, provision for the determination of cranking motor speeds for varying temperatures and voltages.

Some 15,000 copies will be printed. Members who have bought the one copy to which they are entitled at the $1 price may buy additional copies at $10 each. Also companies employing SAE members may purchase copies at $10. Price to all other purchasers is $20 per copy. Foreign postage is $1 additional.

1956 SAE Technical Board

R. F. Kohr
Chairman

C. F. Arnold
B. B. Bachman
L. L. Bower
O. A. Brouer
A. T. Colwell
Trevor Davidson
F. W. Fink
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W. M. Holaday
A. E. W. Johnson
W. C. Lawrence
A. G. Loofbourrow
E. F. Norelius
Harold Nutt
C. L. Sadler
A. E. Smith
D. D. Streid

SECTIONS

MAY 1956

George A. Delaney

C. G. A. Rosen

Presidents Compare Notes On SAE Procedure and Policy

SAE 1955 President C. G. A. Rosen and 1956 President George A. Delaney led off an active Sections Committee meeting at Detroit in January. They compared notes and advice toward improving Section policies and procedures.

Past-President Rosen stated that his visits to the Sections convinced him that the Sections are continually getting stronger, their meetings are improving, and their memberships are growing. He did feel that sometimes the Sections placed too much emphasis on continuity of office. In his opinion, established "ladders" of succession can bring men into chairmanship, whose qualifications may be limited to ability to do other jobs well. Visitors often judge Sections by the impressions made upon them by the chairman, he added.

1956 President Delaney sees the Sections as closest to the heart of the membership of any SAE activity. Most new members, and particularly the younger engineers, get their first impressions of the Society through the Sections and the Section meetings, he said.

In their drive to grow in stature, Sections should strive for papers which will merit publication in **SAE Transactions**, he urged. Sections sometimes try too hard to find papers which have appeal to all members—and the result sometimes is general-interest papers with little professional appeal to anyone. Such papers give the visitor an erroneous picture of SAE's objectives. A truly technical paper delivered by a good speaker will achieve general interest, he stated.

STUDENTS

Interested in a Summer Job?

The SAE Placement Service has prepared a list of SUMMER employment opportunities for distribution to interested SAE Enrolled Students. The list gives specific job openings for which the student may apply directly.

To obtain a free copy, address your request to:

SAE Placement Service
29 West 39th St.
New York 18, N. Y.

Council Amends By-Laws to Increase Sections Committee

The Society's By-Laws have been amended so that the Sections Committee shall now consist of **five** members-at-large, and one representative from each Section elected by and from the Section membership, all to serve during the Society's administrative year. The members-at-large shall be appointed for **five-year terms** and on completion of their terms they shall not be eligible for reappointment until one year has elapsed.

Previously, the Sections Committee has operated with only three members-at-large, and these three members-at-large served three-year terms.

The purpose of these amendments is to provide a larger Executive Committee of the Sections Committee and better continuity of personnel. The Sections Committee Executive Committee consists of the chairman, vice-chairman, the members-at-large, and four members selected from the Section representatives by the chairman.

Mid-Michigan

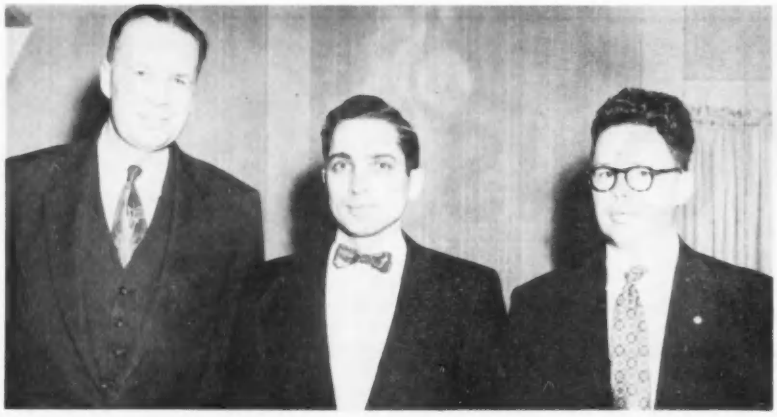
G. W. Colby, Field Editor

Annual Yearbook Includes Section Roster

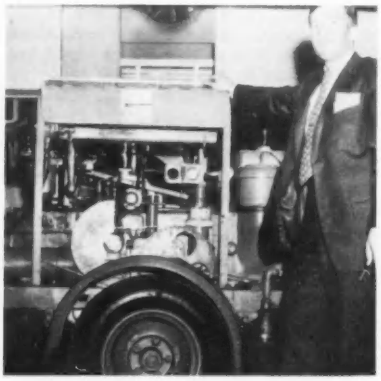
Three years' experience has made Mid-Michigan Section's yearbook a valuable reference item. Now included are:

- Section meetings schedule
- Message from Section chairman
- History of the Section
- Listed names of Section officers and governing board members
- Roster of Section members, listed alphabetically
- Where SAE Members Work, listed alphabetically by companies.

The second and third issues carry



Guest speaker for the Mid-Michigan Section March 12 meeting was Darrel Sand (center), Detroit Transmission Division, GMC. He is joined in this photo by L. L. Otto, Section chairman, (left) and E. E. Malloy, Section program chairman.



Demonstrating a free piston engine air compressor during his talk on "The Free Piston Engine" at the Mid-Michigan April 2 meeting is Gregory Flynn, Jr., General Motors Research, Laboratories Division, GMC.

Presenting an SAE membership pin to new member Harold Noponen, AC Spark Plug Division, GMC, is Section Membership Chairman Morris Graham (left). Presentation was made at the Section April 2 meeting.

New members—16 of them—pose for an official photograph after receiving their membership pins at the April meeting.

Mid-Michigan

G. W. Colby, Field Editor

Continued

advertising, to cover part or all of the costs of this publication. Should a small profit result, as in the third issue, the funds are applied to the Section's student program.

Responsible for the Yearbook is Editor **Gordon Marvin** a member of the Section governing board. He decides what is to be the content, chooses a printer, takes charge of format, proofreading, and distribution.

When he selects a printer, it is only after consideration of such items as printing cost, equipment to do the required job, samples of similar previous work, delivery time, printer reputation, and location of the printer with respect to the editor's home or firm. Many changes in a publication of this type are inevitable. So, the printer and editor should, if possible, be located within the same city, this avoids extensive delays in proofreading and revision.

Provisional Format Set

A provisional format is set at the beginning and later revised according to the size and type of advertising plates, and the imagination of the editor and his assistants in cooperation with the printer.

The appearance of the yearbook has much to do with its success. The cover of each of the three issues published to date points this out. The cover of the first issue had a striking blue background with a large silver SAE emblem. The cover of the second issue featured a map of Michigan showing the location of the Section territory on a buff background. Because the Section territory was enlarged, the third issue featured a similar map outlining the expanded territory. Each issue has been more successful than the last.

One of the most difficult functions of the editor is the maintenance of accuracy. This is accomplished only by careful and patient proofreading. Accuracy of Section membership listings is most easily accomplished by obtaining the desired information directly from the members, either through distribution of a form postcard or by personal contact.

Distribution of the yearbook is made to all Section members, advertisers, and all other Section chairmen.

Yearbook Editor Gordon Marvin feels that the most important contribution of such a publication is a compact listing of the information most frequently wanted by Section members.

SAN DIEGO

R. E. Day, Field Editor

Engineers' Week, Feb. 19–25, was celebrated by San Diego Section in cooperation with all of the engineering and scientific societies of San Diego.

Three SAE San Diego Section members served on the steering committee. **Joseph H. Famme** was a vice-chairman for the committee. **Robert Sharp** was speakers chairman. **Charles Morgan** was San Diego State College chairman.

The aims and objectives of this combined program were:

"1. To inform the public of the contributions the engineers make to our American technology.
2. To interest the student in the high aims and professional achievements which are foundation stones in the engineering profession.
3. To encourage research and development in engineering and the allied sciences.
4. To advance the common good."

To implement the objectives, the San Diego Committee for National Engineers' Week was established. This committee consisted of representatives appointed by the chairmen of the local engineering and scientific societies. These appointees elected officers and divided themselves into seven independent operating committees governed by an overall steering committee.

Commander W. M. M. Fowden, Jr. (right) is shown looking at a Solar Mars gas turbine displayed in the Solar Auditorium, where his talk "Gas Turbines in Marine Applications" was presented before the San Diego Section March 20. Paul A. Pitt (left), Solar chief engineer, is responsible for Solar's Mars and Jupiter gas turbines, which are used in a variety of applications by the U. S. Navy.

SAE members Robert G. Sharp (center), San Diego Section chairman, and W. C. Heath (right) were active participants in the San Diego "Engineers' Week" festivities. They are shown in discussion with Marshal of the Royal Air Force Sir John C. Slessor, speaker at the dinner marking National Engineers' Week on Feb. 24.

Heath is chairman of the ASME San Diego Section.

KANSAS CITY

H. H. Hart, Field Editor

Governing Board members of the Kansas City Section have taken over as a telephone squad to promote meeting attendance. Each member has a list of Section members to call and remind of the monthly meetings. Result: a noticeable increase of attendance.

ST. LOUIS

F. H. Roever, Field Editor

Missouri School of Mines and Metallurgy Student Branch held its technical paper contest at the March 7 meeting. The Branch holds its own technical paper competition to choose participants for the contest with Parks College students sponsored by St. Louis Section. (See page 92, March Journal.)

The Branch awarded first prize to **John Feemster**, speaking on "Buckets for Pistons." Second prize went to **Sam Gulotta** for his paper on "Roll Bond Process." **Roger Berkbigler**, Student Branch chairman, received third prize for his talk on "Lacquers vs. Enamels for Automotive Finishes." The fourth contestant was **Gus Link**, who spoke on "Synthetic Lubricants."

The three winners met with the winners from Parks College Student

CONTINUED

Section Meetings

ALBERTA

May 18 . . . Special Ladies Night. Al San Club.

BUFFALO

May 15 . . . Sports Car Meeting. **Robert T. Jackson,** sales engineer, Perfect Circle Corp., Hagerstown, Ind.—"Indianapolis Racing Car Design." Automobile Club of Buffalo, Clarence, N. Y. Dinner 7:00 p.m. Meeting 8:00 p.m.

CANADIAN

May 25 . . . **Russell E. Kaufman,** truck transmission engineer, Chevrolet Motor Division, GMC., Detroit.—"Chevrolet Powermatic Transmission." Genosha Hotel, Oshawa, Ont., Canada. Dinner 6:30 p.m. Special Features: Golf in the afternoon.

CENTRAL ILLINOIS

May 28 . . . Member Meeting. Papers by: **Ralph Clark, Ed Eckert,** and **R. C. Barnes.** Hotel Pere Marquette. Dinner 6:30 p.m. Meeting 7:45 p.m.

CHICAGO

June 1 . . . Annual Ladies Night. Cocktails — Dinner — Entertainment—Dancing—Music. South Shore Country Club.

CINCINNATI

May 28 . . . Plant Tour of Trailmobile. Dinner 6:30 p.m. Meeting 8:00 p.m.

CLEVELAND

May 14

DETROIT

May 17 . . . General Motors Technical Center, Warren, Mich. Production and Student Activities Meeting.

INDIANA

May 17 . . . Annual 500 Mile Race Meeting. **A. E. Kimberly,** chief engineer, DeSoto Division, Chrysler Corp.—"Winning the First Lap." **Duane Carter** will comment on immediate and long range plans of the new United States Auto Club. Marott Hotel, Indianapolis. Dinner 7:00 p.m. Meeting 8:00 p.m. Special Features: Social Half-Hour 6:30 p.m. Film of 1911 and film of 1955 500 Mile Race.

METROPOLITAN

May 16 . . . Fuel & Lubricant Activity Meeting. **C. H. Morris** and **R. R. Normandin,** Marine & Industrial Division, Chrysler Corp. —"What's Happening to Gasoline Marine Engines." The Midston House, 38th Street and Madison Avenue, New York. Meeting 7:45 p.m.

MID-MICHIGAN

May 14 . . . Ladies Night. **Henry Lauve,** Styling Section, GMC, GM Bldg., Detroit.—"Motorama Dream Cars." Old Auditorium, Lansing, Mich.

MILWAUKEE

June 9 . . . Ladies Night

MONTREAL

May 14 . . . Symposium—"Basic Principles of Fleet Maintenance." Sheraton-Mount Royal Hotel. Dinner 6:15 p.m. Meeting 7:45 p.m.

NEW ENGLAND

May 14

NORTHERN CALIFORNIA

May 23 . . . Past Chairmen and Old Timers Night. Engineers Club, San Francisco. Dinner 6:30 p.m. Meeting 8:00 p.m. Special Features: 25 and 35-year Membership Certificates to be presented.

South Bay Division

May 8 . . . **Robert A. Wagner,** chief engineer, Hiller Helicopter Corp., Palo Alto, Calif.—"Developments and Problems in VTO Aircraft." Field Trip through Hiller Helicopter Corp. 4:00 p.m. Dinner at Old Plantation, Los Altos 7:00 p.m. Meeting 8:00 p.m.

PITTSBURGH

May 16 . . . **Mauri Rose,** vehicle development engineer, Chevrolet Motor Division, GMC, Detroit.—"Stock Car Racing." Franklin Club, Franklin, Pa. Dinner 6:00 p.m. Meeting 7:45 p.m. Special Features: All Day Meeting. Golf at 1:00 p.m. Wanango Country Club, Reno, Pa.

ST. LOUIS

May 21 . . . **Robert J. Ruppe,** superintendent, Shops & Equipment, Chicago Transit Co., Chicago, Ill.—"Engineering in Maintenance." Gatesworth Hotel. Dinner 7:00 p.m. Meeting 8:00 p.m.

SAN DIEGO

May 9 . . . **Floyd Clymer,** noted author and publisher on automotive subjects—"The European Motor Industry."

SOUTHERN CALIFORNIA

May 14 . . . Aircraft Dinner Meeting (Mac Short Memorial Award)

SOUTHERN NEW ENGLAND

May 17 . . . Bradley Field. Social Meeting.

TEXAS GULF COAST SECTIO
South Texas Division

May 25 . . . Annual Dinner-Dance Party. Party House on Highway 281 North. Social hour 7:30 p.m. Dinner 8:30 p.m.

WESTERN MICHIGAN

May 15 . . . **Clifford N. Hinkle,** agricultural engineer, Standard Oil Co., Chicago, Ill.—"Engineering Magic." Doo Drop In, Muskegon, Mich. Dinner 7:00 p.m. Meeting 8:00 p.m. Special Features: This will be our Father and Son Meeting.

June 9 . . . Ladies Night. Dinner and Dance. Prospect Point Hotel, Spring Lake, Mich. Dinner 8:00 p.m.

Branch on the Parks College campus March 21. The event was the St. Louis Section Annual Student Night Program.

More than 100 Section and Student Branch members, guests, and faculty people, toured the campus and ate in the college cafeteria. Then they heard the Student Technical Papers in the Student Lounge.

First place winner was **John Feemster,** Missouri School of Mines and Metallurgy, who spoke on "Buckets for Pistons." **Charles Tringali,** Parks College, won second. His paper: "Automatic Voltage Regulation for Aircraft." Third place went to **Sam Gulotta,** Missouri School of Mines and Metallurgy, who discussed the "Roll Bond Process."

Prizes of $25.00, $15.00, and $10.00 were given by **Section Chairman Clifford Feiler.**

All six contestants, if they apply and are elected to SAE membership, will have their first year dues paid by the Section.

The Missouri School of Mines and Metallurgy also won the Section banner and will keep possession until the Parksmen can win it back again.

Attending from the Missouri faculty were: **Dean Curtis L. Wilson;** Professors **Charles Remington, Gordon Scofield, Ralph Schowalter,** and **Eugene Chase**; and **Lyle Beltz.**

CINCINNATI

H. E. Pitzer, Field Editor

Fred Heinlein Stars In "This is Your Life" Salute

The first chairman of Cincinnati Section was the guest of honor at the Feb. 27 meeting, designated **"Fred Heinlein Night."** Over 200 members and guests were present to celebrate his retirement from the Cincinnati Gas & Electric Co.

1956 SAE President George A. Delaney, the Section's most distinguished guest, spoke a few words in thanks to Heinlein for his services to SAE.

Another special guest was **1953 SAE President Robert Cass,** during whose administration Heinlein was installed as first chairman of the Section.

Hollister Moore, SAE manager, Sections and Membership Division, also attended as a representative of SAE headquarters in New York.

As soon as Heinlein had been seated comfortably in an easy chair, the highlight of the evening began. Arthur Cherry, a business associate of Heinlein, assumed the part of Ralph Edwards of "This is Your Life" fame.

He switched out the ballroom lights and called for the first slide. On came "bare" Fred, at the tender age of one, lying face down on a bearskin rug. The slides then followed him through his early positions with Cincinnati Gas & Electric Co., his service in World War I, his romances, his marriage, and his later years with Cincinnati Gas & Electric. His many contributions to the automotive industry were brought into focus: mobile truck mounted air compressors, crew and equipment trucks, the use of oil filter cartridges in operating engines.

It was a memorable tribute to a busy man.

Heinlein expressed sincere and deep appreciation for the entire program. Since he plans a much needed rest and trip to Florida, **Section Program Chairman John McKinney** presented him, in behalf of many SAE friends, a three lense movie camera for recording his trip for future memories.

"Fred Heinlein Night" distinguished guests, seated at the speaker's table, include left to right: Fred Heinlein himself, first chairman of Cincinnati Section; 1955–1956 Section Chairman Fred Biederman; 1956 SAE President George A. Delaney; and Robert Cass, 1953 SAE president.

No. California

L. J. Abell, Field Editor

San Jose State College Student Club predicts that its present membership will be doubled next year. Attendance at its meetings has been steadily increasing during the past year.

E. S. Starkman, associate professor of engineering, University of California in Berkeley, spoke on the behavior of engines burning nitroparaffins at the March 28 meeting.

No. California Section South Bay Division

Officers of the Northern California Section were guests at the South Bay Division meeting April 3 to hear speaker A. G. Spear (center right) of Ford Motor Co. give the paper, "How a Car Is Born." The officers are (left to right) Irving Harlow, Central Valley representative, C. F. Carey, Program co-chairman of South Bay Division, and Warren G. Brown, chairman of the Section.

South Bay Division's membership list has increased to 100 during 1955–1956, the second year of Division activity.

Members get acquainted with guests

1.

at each meeting to help them better understand the purpose and activities of SAE.

Jack V. Harris, Membership chairman, is usually found at the meal ticket desk passing out membership forms to the people who obtain guest lapel cards.

Program Co-Chairman C. F. Carey (left) thanks guest speaker, A. G. Spear, manager, special projects department, Ford Motor Co., for presenting the paper "How a Car Is Born" at the South Bay Division of the Northern California Section on April 3, 1956.

2.

3.

MONTREAL

A. A. Larkin, Field Editor

1. 1956 SAE President George A. Delaney, guest speaker on "Designing An Automobile" at the Montreal Section Feb. 20 meeting, receives a memento of his visit from Section Chairman Ed Jennings. His gift is a lamp and shade handcarved in wood by a noted French Canadian artist-craftsman.

2. Five chairmen of Montreal Section join with SAE President George Delaney for this group photo. Seated are left to right: W. S. Cowell, Montreal Section's first chairman; President Delaney; 1955–1956 Section Chairman Ed Jennings; and 1953–1954 Chairman L. Vauthier. Standing are: 1954–1955 Chairman H. W. Royl and 1952–1953 Chairman Herman Eberts.

3. 1956 SAE President George A. Delaney signs the Golden Book at the City Hall on the occasion of his visit to Montreal Section. With Delaney are left to right: Section Chairman Ed Jennings; His Worship Mayor Jean Drapeau; Hollister Moore, SAE manager, Sections and Membership Division; Maurice Bourgault, Arrangements Committee chairman; and T. Cawley, General Motors Products of Canada, Ltd.

Metropolitan

Leslie Peat, Field Editor

An all-day tour of the new Mahwah, N. J., Ford Assembly Plant was taken Feb. 8 by 322 members of Met Section and their guests.

Hosts at Ford for the event were: **A. M. Harris,** plant manager; **S. K. Cannon,** assistant plant manager; **G. C. Biggar,** manager of plant engineering; **C. A. Kiorpes,** manager of manufacturing engineering; **D. J. Long,** fleet sales manager, Northeast Region; and **J. E. Campbell,** regional service manager.

The tour was arranged by **George E. Wilson,** Section vice-chairman for Passenger Car and Body Activity, and his assistant, **O. S. Grunden.** Wilson is automotive administrator for Lever Brothers Co. Grunden is regional director, fleet section, General Motors Corp.

Guests and hosts at the Metropolitan Section plant tour of the Mahwah, N. J., assembly factory of Ford Motor Co. included: Standing, left to right: A. M. Harris, plant manager; George E. Wilson, Section vice-chairman for Passenger Car and Body Activity; S. K. Cannon, assistant plant manager, and Hollister Moore, SAE manager, Sections and Membership Division. Seated, left to right, are Charles E. Chambliss, Jr., Section vice-chairman; G. C. Biggar, manager of plant engineering; C. A. Kiorpes, manager of manufacturing engineering, and David J. Long, Ford fleet sales manager, Northeast Region, Ford Division.

Truck cab being lowered on chassis at one stage of assembly at the new Ford Motor Co.'s Mahwah, N. J. plant.

J. E. Campbell, Ford regional service manager, explaining an engine assembly in a chassis to part of the group.

David J. Long, Ford fleet sales manager, Northeast Region, Ford Division, left, and J. E. Campbell, Ford regional service manager, show off an assembled vehicle to George E. Wilson, Section vice-chairman for Passenger Car and Body Activity.

Completed car rolls off the assembly line at the Ford Motor Co.'s Mahwah, N. J. plant with a part of the Metropolitan Section group in the background, watching the proceedings as they are directed along the tour route by Ford plant officials.

Dr. Arthur Nutt, 1940 SAE president, welcomes Willey Ley, scientist and author-lecturer, as guest speaker before Southern New England Section's Jan. 17 meeting. His subject was "Conquest of Nearby Space."

Willey Ley, guest speaker, holds a special discussion with sons of SAE Southern New England Section members after his talk before the Section at the Jan. 17 dinner meeting.

So. New England

S. L. Leavitt, Field Editor

Section Undertakes TV Public Education Program

As part of its 20th Anniversary Program, Southern New England Section strove to make the general public aware of the contributions given by SAE to their everyday living. Members offered a panel discussion of "What the SAE Means To You" on Station WGTH-TV.

The panel members were as follows: **1955–1956 Section Chairman R. E. Johansson; Frank P. Gilligan,** the Section's first chairman; **W. Paul Eddy,** Pratt & Whitney Aircraft Division, United Aircraft Corp.; and Charles Norwood, WGTH-TV. They got together for one rehearsal before broadcast time.

The broadcast was presented on March 12. With Norwood acting as moderator, the panel launched into the 15 minute discussion.

Charles Norwood (center), WGTH-TV news director, opens the March 12 TV panel discussion on "What the SAE Means to You" by introducing Section dignitaries. Left to right are: W. Paul Eddy, Pratt & Whitney Aircraft Division, United Aircraft Corp.; Joseph J. Krason, Section Public Relations Committee chairman; Charles Norwood; Robert E. Johansson, 1955–1956 Section chairman; and Frank P. Gilligan, the Section's first chairman.

Eddy gave a brief overall description of SAE organization and the scope of its activities.

Gilligan continued with a discussion of some of the standardization activities of the technical committees, showing their effect on the general public's everyday living. He brought in such items as automobile headlights, tires, rims, SAE numbers on oils, and many aeronautical standards.

Johansson closed the program with a brief summary of the contributions of the local Sections. He stressed that each Section operates like the parent organization in miniature, and touched upon the progress of the Southern New England Section in bringing an understanding of technological advancement to both its members and the general public.

Here is the story behind that TV panel discussion:

At the Section's 20th Anniversary Meeting on Jan. 17, **J. V. Krason,** Section Public Relations Committee chairman, arranged to have station WGTH-TV film the arrival of Willey Ley, German-born scientist and author-lecturer. Included in that film was a short interview in which Ley mentioned that the purpose of his visit was to talk before SAE.

After the program was aired, the station received several calls from the home audience inquiring about SAE. This led Charles Norwood, WGTH-TV news director, and Krason to the idea that a program explaining the function of SAE would be of benefit.

The Johansson-Gilligan-Eddy-Norwood panel discussion was decided upon and held on March 12.

Actual preparation was left up to each panel member. Each wrote his

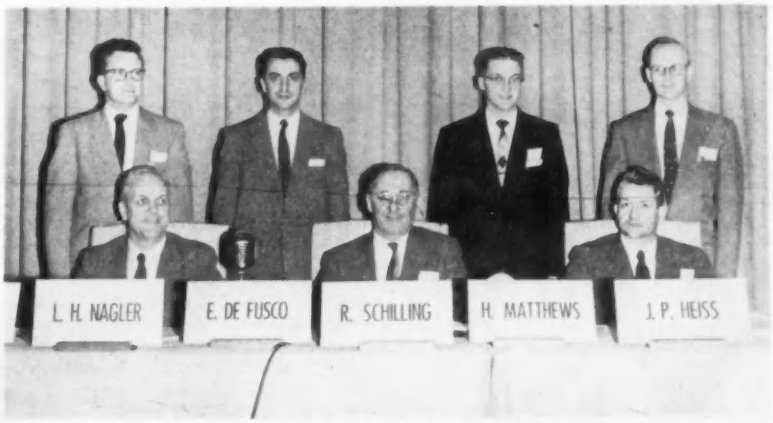
CONTINUED

own questions and the answers to be supplied by the moderator. Each also had to tailor his part to the rigid time limit imposed by TV.

Through the cooperation of WGTH-TV, the program was presented at a convenient evening hour. The reception covered much of New England.

Response to the program was aided by active publicity in the local newspapers.

Already, future programs are in the planning stages.



Detroit Junior Group's Feb. 6 meeting featured a panel discussion on "The Human Automobile." Members of the panel were (left to right): J. C. McInnis, Chrysler Corp.; L. H. Nagler, American Motors Corp.; E. De Fusco, General Motors Corp.; Robert Schilling, GMC.; Horton Matthews, Vickers, Inc.; J. P. Heiss, Thompson Products, Inc.; and R. F. Jenson, American Motors. Subjects covered were: "Human Dynamics of Control," "Car Dynamics," "Automotive Control Components," and a discussion of the future "Human Automobile."

DETROIT

W. F. Sherman, Field Editor

A novelty program and menu was provided as a special treat by the Truck and Bus Activity Committee of Detroit Section at its Feb. 20 dinner meeting. This compact fact-filled document provided the announcement of the speaker and subject; the dinner menu, described in savory terms; a calendar of future Detroit Section events; the program for the evening, including a short biography of the speaker; and blank space labeled as follows:

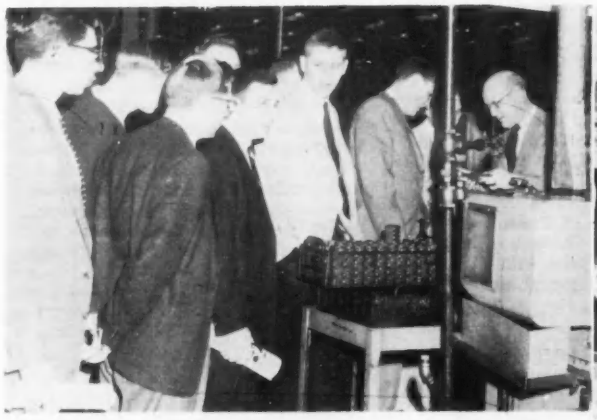
"This space for Question and Answer period—If you have no questions, this space can be used for calculations and sketches or funny pictures and doodling, for good engineers cannot talk without a pencil in hand and some space."

T. F. Schrag, Clark Equipment Co., is vice-chairman in charge of Truck and Bus Activity. His assistant vice-chairman is **F. J. Koehl,** Ford Motor Co.

They were responsible.

General Motors Institute Student Branch was treated to a tour of Saginaw Steering Gear Division GMC plant on March 15. After the tour, Don Marquis, assistant chief engineer, gave a talk, supplemented with slides, relating the positions of the parts design engineer and the automotive engineer.

Don Marquis, Saginaw Division, speaking before the group after the tour.



Tom Snyder (far right), Saginaw Division, explains the internal thread grinding operation on the ball nut to a group of General Motors Institute Student Branch members.

Bill Eichler (far right), Saginaw Test Laboratory, describes the lab's function to another group of GMI Student Branch members on their tour of the Saginaw Steering Gear Division plant, GMC.

Engineered FOR THE Tough Jobs

....CONTINENTAL RED SEAL POWER

The new 4-wheel drive Oshkosh 50-50 ready-mixed concrete carrier is built to haul up to 5 cubic yards legally, with enough water for ready-mixed concrete operations. Its Continental Red Seal B6427 engine is cantilevered forward of the front wheels, distributing the load equally between the two axles, and making the unit conform to maximum load limits in most states . . . Continental F4162 engine driving the 4½ cu. yd. Rex Adjusta-Wate Moto-Mixer is mounted at rear of the machine, making possible the most efficient load distribution over all axles, for carrying maximum payload.

• • •

When it comes to tough jobs, the hauling of ready-mixed concrete ranks well toward the top of the list. It takes a real engine merely to move such a monster as that shown above, to say nothing of lugging it over all sorts of terrain in order to spot the load. Continentals have been known for dependability for more than half a century. Their famous in-built stamina is earning them a place in more and more of today's heavy-duty equipment, not only in transportation but in industry and farming as well. Every Continental Red Seal is built for the job in which you find it—and backed by service and parts facilities coast to coast.

•

Continental Motors Corporation

MUSKEGON AND DETROIT

About SAE Members

Continued from page 95

R. N. BURCKHALTER is now sales manager for Michiana Filter Division of Indiana Commercial Filters Corp. This corporation is a new subsidiary of Commercial Filters Corp., formed with the merger of Honan-Crane and Michiana filter lines.

He had been manager of Sheet Steel Division, Michiana Products Corp.

FRANK P. WATSON is now a design engineer with Northrop Aircraft, Inc. He is concerned with the design of aircraft controls and missile launching equipment.

Watson was previously a designer with A. V. Roe Aircraft, Ltd., Toronto.

MARTIN G. SACHS has joined General Electric Co. Jet Engine Department in Cincinnati. He had been with Standard Rolling Mills Division, Revere Copper & Brass, Inc., Chicago, as a design and detail draftsman.

EDWARD T. RAGSDALE has been named general manager of Buick Motor Division, GMC.

Ragsdale, with Buick since 1923, was general manufacturing manager. He joined Buick in 1923 as a draftsman in the body division. He became assistant chief engineer in 1939 and general manufacturing manager in 1949.

JOHN WALDHERR, JR. has joined Airtex Products, Inc. in the position of director of engineering. He has been general manager of Wells Mfg. Corp.

ALARIC C. SCHLIEWEN is now a staff assistant to the general manager of manufacturing with White Motor Car Co. He has been vice-president of manufacturing for Pierce Governor Co., Inc.

RICHARD C. AYLWARD has been named general sales manager for Bohn Aluminum & Brass Corp., according to **TERRY W. KUHN,** executive vice-president.

Aylward moves from Chicago, where he was manager of Bohn's Midwest Region, including Chicago, Milwaukee, St. Louis, Minneapolis, and Moline.

He will take up headquarters in Detroit.

FRED EBERHARDT has been elected chairman of the board of Eberhardt-Denver Co. of Denver. He is the founder of the company.

The announcement came with reorganization following the purchase of the company by Morse Chain Co., a Borg-Warner Corp. subsidiary.

GEORGE M. SCHUEDER, works manager of the Evans Products Co., has been elected a vice-president of the company.

Schueder, who is in charge of production and engineering, was named to his new post during a recent meeting of the company's board of directors.

GEORGE M. F. CARTER, formerly a design engineer (group leader) with Cessna Aircraft Co., has joined Rohr Aircraft Corp. as a design engineer.

The abbot and the Musclebound File Clerk

The *abbot* studied the snapshot sympathetically and read the scented letter. "You must help me, kind sir," it pleaded. "For years I've struggled with overloaded, sticky file drawers. Look at me! I'm so musclebound people think I'm a lady wrestler instead of a file clerk."

The little man had a ready answer, this time. Seating himself at his photo-electronic typewriter, he wrote, "Ask your employer to invest in up-to-date files equipped with drawers that glide — smoothly and effortlessly — on ABBOTT *Deep Hardened* and *Tempered* carbon steel bearing balls. They open and close at the touch of a finger!"

Abbott bearing balls have unlimited uses because they possess great shock resistance and perform efficiently under high load factors. These *special* properties come from Abbott's unique manufacturing processes and quality control which amply justify the name . . . ABBOTT — "the Ball with the Armored Heart".

ABBOTT

Want to learn more about the little man — and how he can help you? Drop a line to . . .

The ABBOTT BALL Company

115 Railroad Place, Hartford 10, Conn.

About SAE Members

Continued from page 110

JACK M. CHERNE has joined Hughes Tool Co., Aircraft Division, Culver City, Calif., as a project engineer in helicopter development.

He has been assistant chief of structures for Sikorsky Aircraft Division of United Aircraft Corp.

RAYMOND NIVET has become assistant to the deputy director general (Technical), Air France. He has been serving as head engineer in technical management for the company.

WALTER C. ZEYTE has become a Chevrolet Motor Co. project engineer in the design and testing of the passenger car front suspension system and the manual steering mechanism. He has been a senior designer of passenger car chassis for the company.

ROBERT M. LADEVICH has joined the staff of the Whiting Research Laboratories of the Standard Oil Co. (Indiana). He has been with Armour Research Foundation as an engine research laboratory supervisor.

JUDSON T. BENNETT has joined Thompson Products, Inc., Cleveland, as a research engineer, following his recent graduation in mechanical engineering from Fenn College.

A member of the Fenn College Student Branch, he served as chairman of the Branch during his senior year. He was recently with Arthur G. McKee & Co. as part of his college cooperative work experience.

VINCENT G. POLOVKAS is now associated with the Engineering & Development Branch, Fairchild Aircraft Division, Fairchild Engine & Airplane Corp., as a project engineer. He is located in St. Augustine, Fla.

Polovkas was a senior structures engineer for Convair Fort Worth Division, General Dynamics Corp.

JOHN R. LIGGETT is now in Cleveland as district manager for Foote Bros. Gear & Machine Corp. He had been a field engineer for the corporation in Detroit.

CHARLES D. HEALEY has moved to the Plainfield, N. J. plant of Mack Mfg. Corp. to serve in the Service Engineering Department. He had been a district service manager in Detroit.

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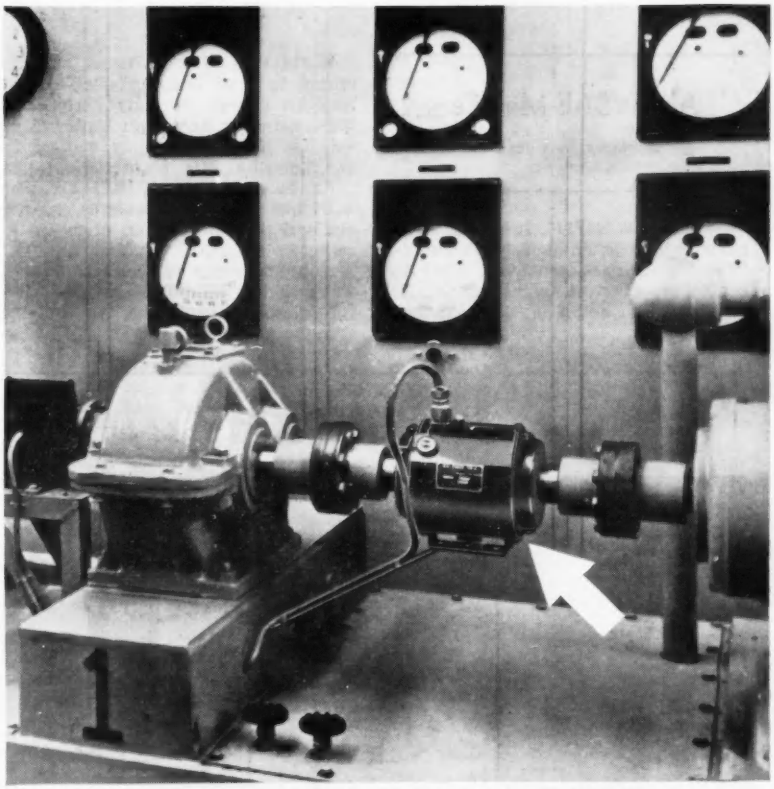

Royal Dutch Airlines uses SR-4 torquemeters for testing superchargers.

read torque directly in inch-pounds with Baldwin SR-4® torquemeters

Coupled into a line of shafting, this strain gage type pick-up measures shaft torque directly and transmits signals to appropriate instrumentation. The complicated equipment involved in measurement of reaction torque is entirely eliminated.

SR-4 torque pick-ups have been built for shafts from ¼" to 18" in diameter. Speeds range from 0 to 30,000 rpm. Capacities range from 10 inch-ounces to 4,800,000 inch-pounds. Guaranteed accuracy up to ±¼%.

For complete information on this versatile equipment, get your copy of our SR-4 torquemeter bulletin. Write Dept. 2556, Electronics & Instrumentation Division, BLH Corporation, 806 Massachusetts Avenue, Cambridge, Mass.

BALDWIN BLH LIMA-HAMILTON

ELECTRONICS & INSTRUMENTATION DIVISION
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DIVISIONS: Austin-Western • Eddystone • Lima • Hamilton • Loewy-Hydropress • Madsen • Electronics & Instrumentation • Pelton • Standard Steel Works

About SAE Members

Continued from page 111

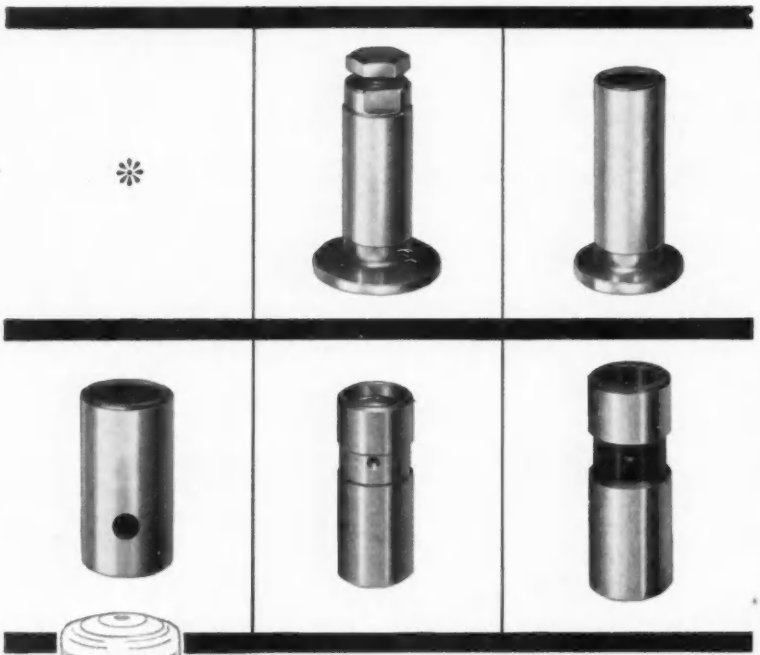
SEYMOUR ROTH, formerly an experimental test engineer with Pratt & Whitney Aircraft Division, United Aircraft Corp., is now an instrumentation engineer for Radioplane Co., Van Nuys, Calif.

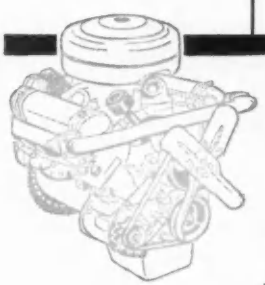
WALLACE JERSTAD has been promoted to chief body production engineer in charge of body activities in Wisconsin for American Motors Corp. He has been chief body engineer at the Kenosha, Wis. plant.

At the same time, **ROBERT F. JENSON** has become accessories engineer. He had previously been assistant accessories engineer.

Announcement of these promotions was made by **MEADE F. MOORE,** vice-president of automotive research and engineering.

JOHNSON *tappets*





keep pace with today's engines

Continual experimentation and excellent manufacturing methods show a steady product improvement that make JOHNSON TAPPETS worthy of your consideration. Only proven materials, covering a range of steel, chilled iron, and various iron alloys are used in the manufacture of JOHNSON TAPPETS, providing greater strength, light weight and increased wear resistance. Serving the AUTOMOTIVE — AIRCRAFT — FARM — INDUSTRIAL — MARINE Industries.

"tappets are our business"

JOHNSON JP PRODUCTS

MUSKEGON, inc. MICHIGAN

PAUL A. PITT, chief engineer, Solar Aircraft Co., has been notified of his reappointment to the subcommittee on combustion by the National Advisory Committee for Aeronautics.

DAVID JUKOFF is now associated with North American Aviation, Inc. as a senior research engineer—components. He had been a mechanical engineer with Bell Aircraft Corp.

JOHN A. SAHS, previously Engine Laboratory assistant for Massey-Harris-Ferguson, Inc., has joined Ford Motor Co. Tractor and Implement Division as a product planning analyst.

JOHN B. McCAULEY, deputy assistant Secretary of Defense, was a visitor to Convair Fort Worth Division, General Dynamics Corp. recently. He was briefed on progress in the B-58 supersonic bomber program. Plant manager, **AUGUST C. ESENWEIN,** welcomed McCauley and supervised his tour.

L. D. THOMPSON has taken a position with Studebaker-Packard Corp. as a product engineer in the Industrial Products Division. He had been superintendent of Diesel experimentation and research for Fairbanks, Morse & Co.

THOMAS H. WIGGINS is now a senior detail draftsman with Fisher Body Division, GMC. He has been in the U.S. Army since his graduation from school in 1953.

THEODORE TRIMBLE, formerly a mechanical engineer with the National Bureau of Standards, Washington, D. C., has joined Ford Motor Co. Engineering Staff as a research engineer.

L. E. CHRISTOFERSON, formerly with the U. S. Air Force as a project officer at Eglin Air Force Base, Florida, is now a junior engineer in the advanced engine design section, Engineering Department, Caterpillar Tractor Co.

BERNARD E. O'CONNOR is now serving with Clemco Aero Products, Inc. as director of engineering. Clemco is a new company in Compton, Calif.

O'Connor has been chief engineer, Aircraft Division, Houdaille Industries, Inc., Buffalo, N. Y.

He served as SAE Buffalo Section chairman in 1948–1949 and has presented several papers before Society meetings.

CONTINUED ON PAGE 114

Q. Does HYATT supply taper bearings, too?

A. Do they! Nearly half of all automobiles built today are equipped with HYATT taper roller bearings!

Surprised? It's a fact—HYATT makes *millions* of fine taper roller bearings every year. And every last one measures up to the traditional HYATT standards of precision and dependability you've learned to expect from America's *first* and *foremost* builder of roller bearings. Yes, in *tapers*, too, HYATT means *highest quality!* Hyatt Bearings Division, General Motors Corporation, Harrison, New Jersey.

GM GENERAL MOTORS

HYATT

STRAIGHT BARREL TAPER

About SAE Members

Continued from page 112

DONALD P. HESS is now chairman of the board and director of Van Norman Industries, Inc., Springfield, Mass. He had previously been a director of American Bosch Arma Corp., Springfield.

GERALD W. DALDER has accepted a position as a product design engineer with Ford Motor Co. Engineering Staff. He has been a ship superintendent, Department of the Navy, Norfolk Naval Shipyard.

EDWARD J. CLARKE is now associated with Studebaker-Packard Corp. as assistant chief draftsman, Advanced Engineering Office. He has been assistant to the chief draftsman with Houdaille Industries, Inc., Research and Engineering Division.

MAXIMUM PERFORMANCE
MINIMUM MAINTENANCE

Through advanced design and creative engineering, BORG & BECK has stepped up the capacity of its passenger car clutches without increasing their over-all dimensions. Compact, light in weight, precision built—for maximum performance, minimum maintenance.

for that vital spot where power takes hold of the load

BORG & BECK CLUTCH · THE STANDARD · Reg. U.S. Pat. Off.

BORG & BECK

DIVISION OF BORG-WARNER

Chicago 38, Illinois

JOHN T. PERTILE is now a district engineer for Kaiser Aluminum & Chemical Sales, Inc. in Kansas City, Miss. He has been production manager with Magna Mill Products, Inc., South Gate, Calif.

C. W. LEMMERMAN, former president of Industrial Sound Control, Inc., which has been acquired by Koppers Co., Inc., will continue to act as a consultant for Koppers. He will also continue his activity in the consulting firm of C. W. Lemmerman, Inc. The firm specializes in industrial noise control, including design of aircraft test facilities.

GENE F. LeROUX has accepted a position with Rocketdyne Division, North American Aviation, Inc., as a research engineer in the Propulsion Laboratory.

LeRoux was a road test engineer, Buick Motor Division, GMC.

CHILTON K. JENSEN, formerly chief test engineer, Reo Division, Motor Wheel Corp., has joined Studebaker-Packard Corp. as a design engineer, Advanced Engineering Office.

PHILIP R. MATRAVERS is now Central district manager (Sales) for Commercial Filters Corp. His offices are in Oak Park, Ill.

Matravers has been manager of the Chicago Branch of the company.

RICHARD D. JACOBS, II has moved to Biloxi, Miss., where he will serve with the Kennedy Marine Engine Co. He had been sales manager for Custom Die Co., Inc., Lansing, Mich.

ERIC G. BOEHM has been appointed general manager of the Hydraulics Division of Houdaille Industries, Inc., according to an announcement by **RALPH F. PEO,** president of the corporation.

Boehm has been associated with Houdaille in various operating executive positions since 1940. He recently has been actively connected with the management of three of the corporation's plants in Decatur, North Chicago, and Detroit.

In 1952 he was assigned to Houdaille headquarters, then located in Detroit, where he was assistant manager of manufacturing.

GEORGE E. KELM has joined American Telephone and Telegraph Co., New York City. He had been superintendent of motor equipment, Michigan Bell Telephone Co., Detroit.

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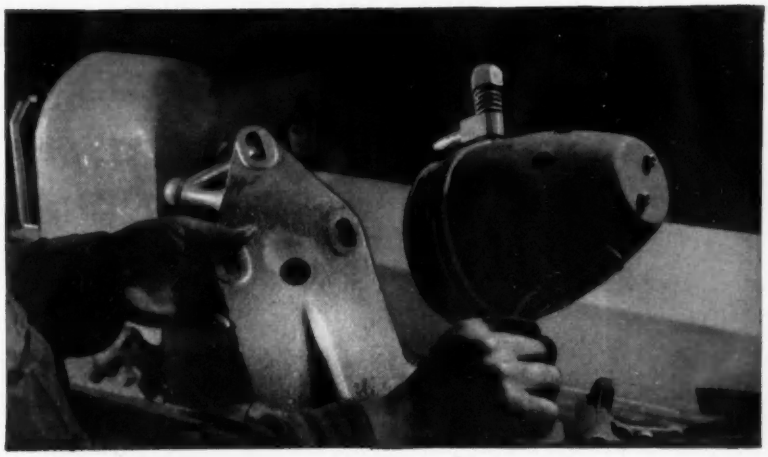
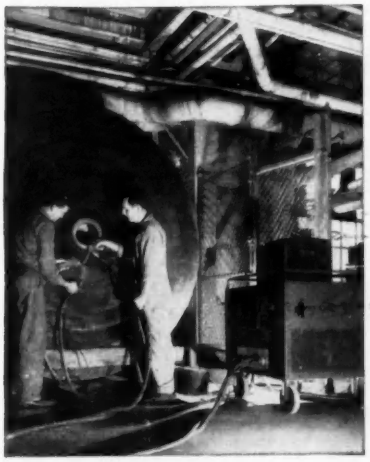


Using Invisible Light to Find Invisible Cracks

A Peoria, Illinois foundry uses Magnaglo and "black light" to make any possible cracks on castings show up as glowing indications. Detection of flaws in the "rough" state means no wasted time in finishing defective castings. Early detection also makes the cause of defects easier to spot and correct. Result? Consistent quality and lasting customer satisfaction.

Inspection Methods: Case Studies

Lower Overall Production Costs Through Nondestructive Testing



Spotting Trouble Before It Happens

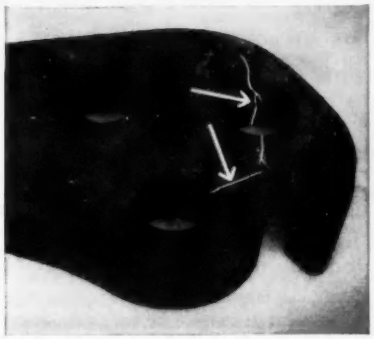
At the Bakelite Company plant in Bound Brook, N. J., inspecting reaction tanks is like seeing your dentist—should be done twice a year. A portable Magnaflux inspection unit is used to find cracked welds in tanks used in making the intermediate resins which go into Bakelite phenolic plastics.

Most manufacturers can achieve definite, worthwhile savings by employing one of the ⋈ methods for improved production control. These nondestructive inspection methods include: Magnaflux, for wet or dry magnetic particle inspection; Magnaglo, fluorescent particle inspection; Magnatest, eddy current electronic testing; Zyglo, fluorescent penetrant inspection; Spotcheck, dye penetrant inspection; and, Sonizon, for ultrasonic measurements.

The ⋈ testing methods are equally effective for preventative maintenance or manufacturing inspection.

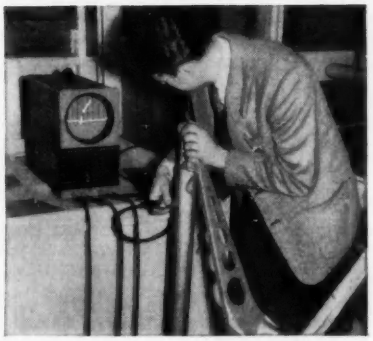
Most manufactured products have as one, or more, of their components some type of casting, forging weldment, machined or formed part. Where cracks cannot be tolerated in the final product, maximum production economy must be obtained from the very outset. Flaws must be discovered as early as possible in order to eliminate further wasted effort in final processing or assembly.

Magnaflux methods pinpoint early flaws and help you eliminate their cause. This results in savings of time, labor and additional long range benefits from increased salvage and reduced amounts of scrap. For detailed information as to how one of the ⋈ inspection methods can help you produce better and save more, write or call for an interview with a Magnaflux engineer. No obligation, of course!



Heat Cracked the Jaw

The jaws of steel strapping machines must be reliable. Yet, following the heat treating, invisible cracks were discovered with Magnaglo as shown above. Immediate correction of the heat treat cycle eliminated the cracks. No further machine time or labor was expended on defective jaw parts.



Watching Your Weight can be important—especially in the aircraft industry. Excess weight can reduce the range and payload of a plane. A major aircraft manufacturer uses ⋈ Sonizon units to ultrasonically measure thickness of sheet and formed shapes. This controls weight by eliminating excessive thickness.

Write for complete details concerning any of the above case studies, (excerpts from MAGNAFACTS), or ask for our new booklet on Lower Manufacturing Costs.

Take Your Inspection Problems to the House of Answers . . .

MAGNAFLUX CORPORATION

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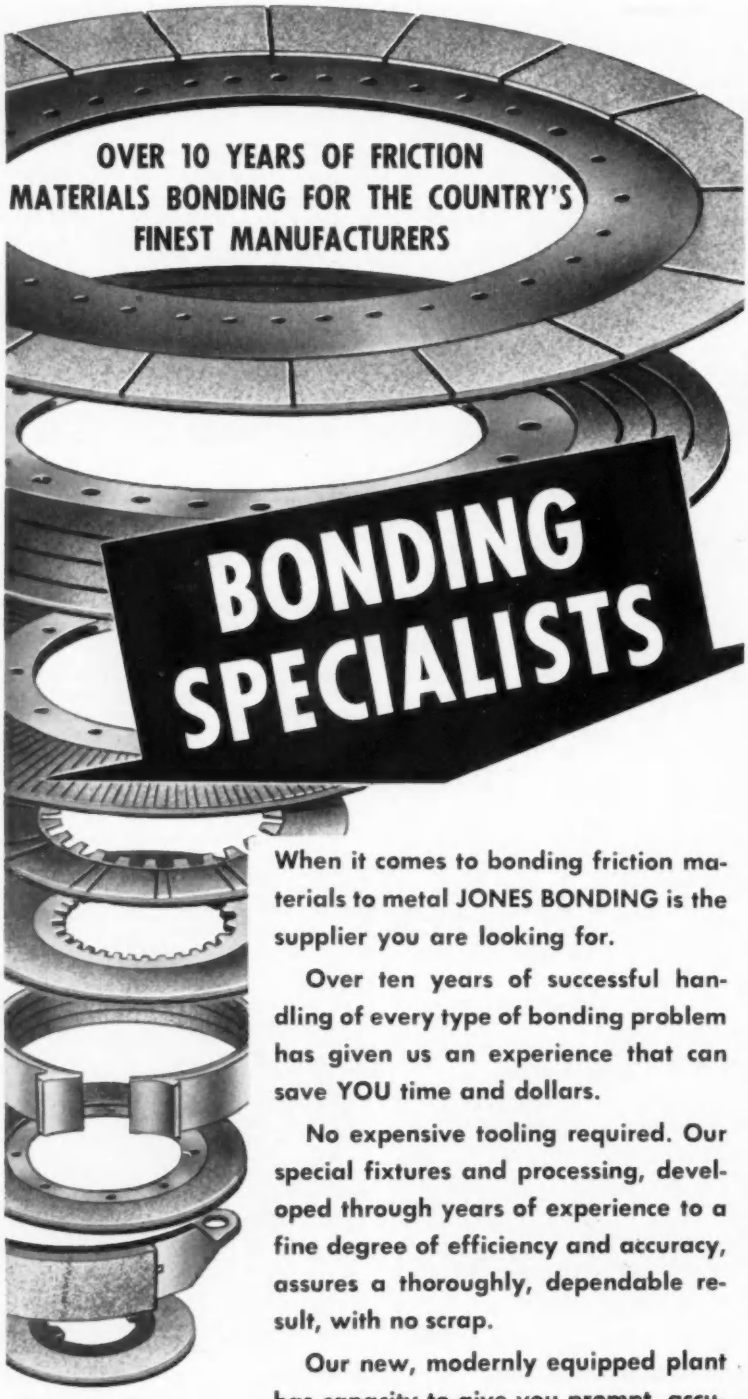

When it comes to bonding friction materials to metal JONES BONDING is the supplier you are looking for.

Over ten years of successful handling of every type of bonding problem has given us an experience that can save YOU time and dollars.

No expensive tooling required. Our special fixtures and processing, developed through years of experience to a fine degree of efficiency and accuracy, assures a thoroughly, dependable result, with no scrap.

Our new, modernly equipped plant has capacity to give you prompt, accurate service at lowest possible cost.

Let us work with you on your experimental and production bonding work.

We do not manufacture or sell adhesives.

PAUL R.
JONES BONDING AND MFG. CO.
124 East Ten Mile Road Hazel Park, Michigan

About SAE Members

continued from page 114

R. LAWRENCE CROSIER, previously a development engineer with Chevrolet Division, GMC, has joined Rocketdyne Division, North American Aviation, Inc., as a research engineer.

LESLIE Y. PARFITT, formerly assistant service engineer, Studebaker Division, Studebaker-Packard Corp., is now a contact engineer with Kokomo Plant Number Two, Chrysler Corp. Supply Division.

JOSEPH S. CARDILLO is now associated with Vickers, Inc. as a project engineer. He had served in the same position with Sargent Engine Corp., Huntington Park, Calif.

DAVID CHARLES WEISS is now associated with the Engineering Research Institute of the University of Michigan as a research associate. He had been a preliminary design engineer for Fairchild Aircraft Division, Fairchild Engine & Airplane Corp.

JOHN W. LAYMAN is now a vice-president of Delano Plastics & Engineering Co., Detroit. He has been a sales engineer for Wells Mfg. Co., Skokie, Ill.

DAVID W. WHITTLESEY is now sales engineering manager for the Western Division, Craig Systems, Inc. He has been vice-president, Mobile Equipment Division, Visioneering Co., Inc.

BERYL R. BRYANT is now associated with Phillips Petroleum Co., Wichita, as a construction engineer. He had been a sales engineer with Waukesha Engine & Equipment Co. of Denver.

GILBERT F. WEISSERT, formerly in layout for Waukesha Motor Co., is now serving in the same position with AC Spark Plug Division, GMC.

P. M. KU has resigned from service with the National Bureau of Standards, Washington, D. C., to join Southwest Research Institute as research engineer in the Engines, Fuels and Lubricants Research Department.

R. U. SAUTTER has recently been transferred to Chicago as district manager for the Torrington Co. He has been a district engineer for Torrington in Milwaukee.

RELIABLE . . . .

Piasecki HUP-2 HELICOPTER

HEIM *Unibal* . . . .

SPHERICAL BEARING ROD ENDS

THE HUP-2 HELICOPTER

The HUP-2 is a tandem rotored, 5-place, single engine land, search and rescue utility helicopter. It is powered by a 525 h.p. Continental engine, has a normal gross weight of 5700 lbs., cruising speed of 80 knots, high speed at sea level of 100 knots, and has a service ceiling of 12,000 feet.

The rotor system of the helicopter is extremely important, being a combination of propellor and wings of the more conventional fixed-wing aircraft.

Its parts must be completely reliable.

HEIM *Unibal* SPHERICAL BEARING ROD ENDS are used in the rotor controls and swash plate of the HUP-2 helicopter.

Heim Unibal Rod Ends are used on all kinds of machines wherever motion or force must be transmitted at odd or varying angles. Applications are unlimited and new uses for these versatile parts are being found every day.

Unibal presents a larger surface supporting area, so they have greater carrying capacities. They take greater axial and thrust loads, last longer, and because of the Unibal design, give maximum correction of misalignment.

A new catalog of Heim bearings has just been completed. Every design engineer and purchasing department should have a copy. Please write . . . .

THE HEIM COMPANY
FAIRFIELD, CONNECTICUT

COMBINED FOR PROFITS—this

You can do things with these new ceramic magnets YOU COULDN'T DO BEFORE!

STACKPOLE

Ceramagnet®

CERAMIC MAGNETS for HIGHER PERMANENCE plus ALMOST 100% ELECTRICAL RESISTANCE . . . AT LESS COST!

THE UNIQUE PROPERTIES of Stackpole Ceramagnet permanent magnets pave the way to new engineering concepts in magnetic usage. Moreover, the low cost of their non-critical ceramic material now makes magnets practical for applications where price of metallic units was formerly prohibitive.

For instance, Ceramagnet offers extremely high resistance to demagnetization—without "keepers" or closed circuit conditions, *and even in the presence of strong opposing fields.* Practically a non-conductor, Ceramagnet is ideal for high-frequency or high-voltage circuits. Coercive force is approximately 1650 oersteds. Remanent induction is 2010 gauss. Weight is only 4.85 gms/cm³. Temperature characteristics including retrace are linear to 400°C.

WRITE FOR BULLETIN RC-10A

Electronic Components Division
STACKPOLE CARBON COMPANY St. Marys, Pa.
Canadian Representative: Wm. T. Barron, P.O. Box 74, Toronto 14, Ont.

Obituaries

Continued from page 95

founder of the company.

Hopkins had served as president of Cleveland Graphite Bronze from 1919–1948 and chairman of the board from 1948–1953.

Upon retiring in 1953, he was made honorary chairman of the board for the year 1953–1954.

He was an active member of the Cleveland Engineering Society.

Hopkins had also held executive positions with Cleveland and Eastern Railroad Co., Standard Dredge Co., Cleveland Short Line Railroad Co., and Belt Line Railroad Co.

THOMAS CARNEY

Thomas Carney, retired engineering manager for International Harvester Co., died Nov. 14, 1955. He had been an SAE member since 1928.

Carney joined International Harvester in 1928 as chief engineer, Springfield Works. Previous to serving with the company, he was associated with Anderson Electric Car Co., Packard Motor Car Co., and Willys Overland Co.

Before retirement, Carney was engineering manager of Foreign Operations for International Harvester.

LOUIS J. HEINRICH

Louis J. Heinrich, sales manager for General Truck Sales Corp., Newark, N. J., died Nov. 22, 1955. He joined SAE in 1928.

Heinrich had served Autocar Sales & Service Co. from 1921 to 1954. He had been district sales manager for Autocar Sales & Service when he became sales manager for General Truck Sales Corp.

Before joining Autocar, Heinrich served with companies such as Pullman Motor Car Co., Republic Truck Co., Schults Bread Co., and Swinehart Tire Agency.

EMORY N. KEMLER

Emory N. Kemler, professor, Mechanical Engineering, head, Machine Design, University of Minnesota Department of Mechanical Engineering, died Dec. 6, 1955. He had been with the University since 1951.

Kemler got his BS in Mechanical Engineering from the University of Kansas, then attended the University of Pittsburgh for his Ph.D. in 1934.

He served in industry as a student trainee for Dodge Mfg. Corp., and as a research engineer for Gulf Research & Development Corp.

He became an instructor in mechanical engineering at the University of Pittsburgh in 1929. In 1934 he became an associate professor. He served Gulf Oil Corp. Gypsy Division from 1936 to 1940 as chief production engineer. Then he returned to teaching as an

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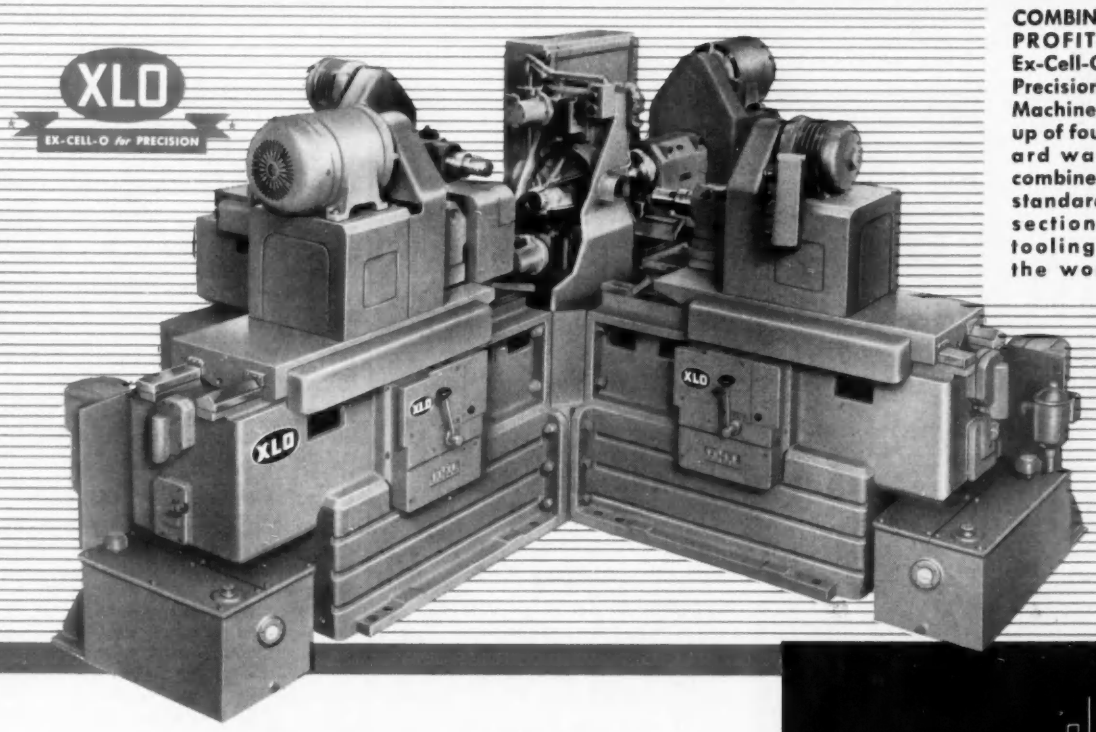
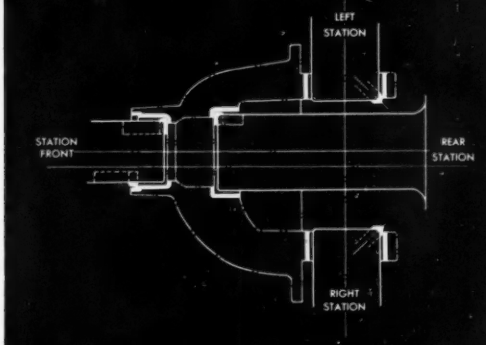


COMBINED FOR PROFITS—this Ex-Cell-O 4-Way Precision Boring Machine is made up of four standard way units combined with a standard center section, with tooling to suit the work.

4 HOLES, 90° APART, BORED SIMULTANEOUSLY

BY EX-CELL-O 4-WAY MACHINE



SIMULTANEOUS MACHINING of four holes assures a 90° relationship between bearing bores and pinion bores.

This differential carrier assembly requires the boring of accurate holes at right angles to one another. Bore diameters are held as close as .0005". Shoulders must be square with bores. Bearing bores must be square with pinion bores.

Here was an opportunity to combine operations by using an Ex-Cell-O 4-Way Precision Boring Machine, with these profitable results:

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PRECISION—accurate bores, holding the 90° relationship, are produced by precision spindles, smooth, hydraulically operated slides, and accurate location of the way units.

RELOCATION ERRORS ELIMINATED—since the part is located and clamped only once, there can be no errors caused by relocating and reclamping.

Is there an opportunity to cut costs and combine operations in your product? These way-type precision boring machines, special machines composed of standard units, also are used in automated production lines. They can be placed side by side and connected with transfer type fixtures to form transfer machines, or they can be combined in a transfer machine at those stations where precision boring and similar operations are required.

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Obituaries

Continued from page 118

associate professor at Purdue University School of Mechanical and Aeronautical Engineering.

In 1946 he joined the Southern Research Institute as head of the Engineering Research Division. In 1948–1949 he served in the College of Engineering of New York University.

He was a member of ASME, Society for Promotion of Engineering Education, and the American Petroleum Institute.

ERNEST E. MINARD

Ernest E. Minard, member of SAE since 1913, died July 19, 1955. He was president, National Sales Engineering Corp., Detroit.

Minard had been president of National Sales Engineering Corp. since 1921. Previous to serving with National Sales Engineering, he was with Oldsmobile Motor Works, Studebaker Corp., Federal Mfg. Co., Western Electric Co., and Westinghouse Electric & Mfg. Co.

He was born in Iowa in 1872.

CARLETON H. SCHLESMAN

Carleton H. Schlesman, deputy department chief, Naval Ordnance Laboratory, Department of the Navy, died Nov. 13, 1955. He had been serving the Department of the Navy since 1948.

He obtained his Ph.D. from Johns Hopkins University in 1925. He then joined Standard Oil Co. of New York as a research supervisor. In 1933 he moved to Socony-Vacuum Oil Co., where he became supervisor of the Automotive Division, General Laboratories.

Schlesman was a member of the American Chemical Society, American Petroleum Institute, American Society for Testing Materials, American Association for Advancement of Science, and Gamma Alpha Scientific Society.

YRJO LEIVISKA

Yrjo (George) Leiviska, treasurer, Board of Navigation, Helsinki, Finland, died Sept. 26, 1955. He had been a member of SAE since 1928.

A Finnish citizen, Leiviska came to the United States in 1922 to attend General Motors Institute. He joined Buick Motor Co. in 1926 as a mechanic and served in that position for Cadillac Motor Car Co., and General Motors Truck Co.

He returned to Finland in 1930 to serve as a salesman for Pohjoismaiden Autotuonti O/Y in Helsinki. In 1932 he left that company to study at State University, Helsinki.

His career with the State of Finland started in 1935 when he became an auditor in the General Accounting Office. He became chief treasurer for the Department of Colonization, Minis-

CONTINUED ON PAGE 122

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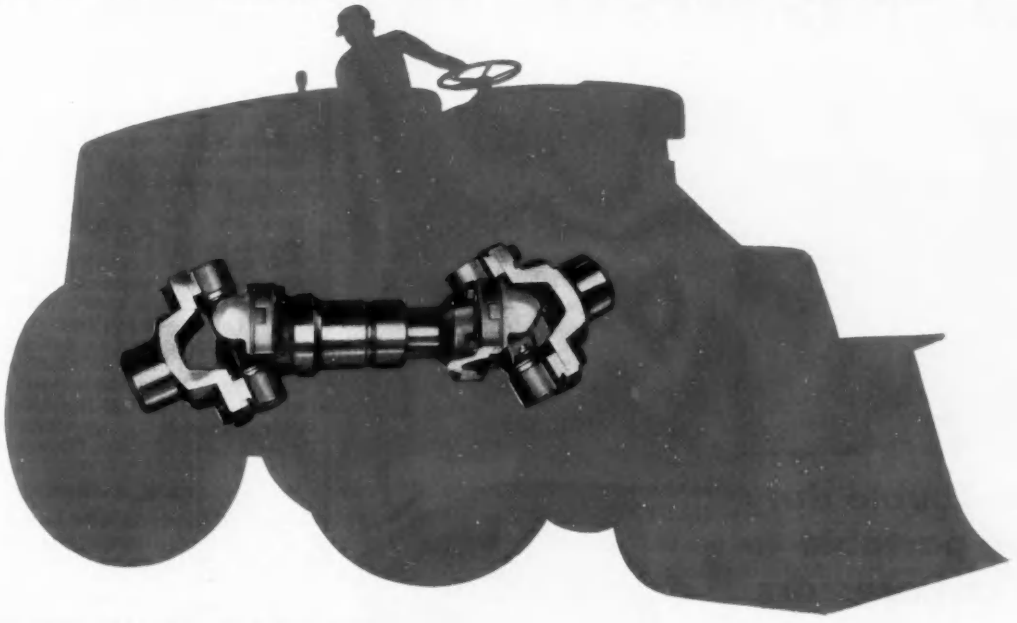

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Obituaries

Continued from page 120

try of Agriculture in 1939 and then treasurer with the Board of Navigation in 1942.

JOHN M. WOOD

John M. Wood, owner of Albany Hardware Specialty Mfg. Co., Albany, Wis., died Jan. 10, 1956. He had been associated with Albany Hardware since 1927.

Wood graduated from the University of Wisconsin in 1917 with a BS in Mechanical Engineering.

He started his industrial career with Falk Co., Milwaukee, as a draftsman. From then until he centered his career around Albany Hardware, he was associated with Packard Motor Car Co., Lincoln Motor Car Co., Stout Engineering Laboratories, White Motor Co., and Industrial Fibre Co.

His activities in professional societies included membership in ASME and the Engineering Society of Detroit.

B. J. SEARS

B. J. Sears, branch manager in Seattle for Laher Spring & Tire Corp., died Dec. 22, 1955.

Sears had been a branch manager for Laher Spring since 1929. He had at first been branch manager in Portland.

He joined SAE as an Associate Member in 1946.

HENRY SCHRECK

Henry Schreck, retired Diesel engine pioneer, died Jan. 29, 1956. Before retiring in 1947, he designed and supervised the building of the Diesel engine used in present streamlined Diesel locomotives for the American Locomotive Co., now Alco Products, Inc.

Schreck had been notified just before his death that he had been chosen to receive a citation from ASME for his outstanding achievements in the Diesel field. He was a Life Member of ASME.

Born in Hamburg, Germany, Schreck attended engineering schools in Germany, obtaining an ME from the Royal Academy of Berlin-Charlottenburg in 1905. He came to the United States in 1914.

At that time Schreck was one of the few mechanical engineers in this country with a working knowledge of diesels. He was employed for three years at the Fulton Iron Works as assistant chief engineer and then as chief engineer. Later, as a consulting engineer, he worked for Ingersoll-Rand Co.; Fairbanks, Morse & Co.; American Locomotive Co.; and Lombard Governor Co.

CARL R. HENNICKE

Carl R. Hennicke, vice-president and chief engineer, United Mfg. Co., Bedford, O., died recently. He had been an SAE member since 1917.

He started in industry as a draftsman for Lippard-Stewart Motor Car Co., Buffalo, N. Y., in 1912. By 1919 he had become chief engineer for Eberhard Mfg. Co., Cleveland. He continued in this position until 1945, when he moved to United Mfg. Co. in the same position.

He became vice-president and chief engineer, the position he held at the time of his death, in 1951.

ARTHUR E. DeKOME

Arthur E. DeKome died on Nov. 10, 1955.

DeKome was vice-president in charge of Operations for Lin-O-Cast, Inc., Cleveland, at the time of his death. He had joined Lin-O-Cast in 1954.

He started in industry as an apprentice with Cleveland Hardware Co. in 1911. In 1929 he became the owner of Roll-Away Skate Co. He sold his interests in Roll-Away to officials of the company in 1938 and joined National Formetal Co. as chief engineer

CONTINUED ON PAGE 124

...do double duty on portable air compressors

As the picture shows, YA Radiators do time on the rock pile, too! As standard equipment on many of America's most rugged portable air compressors, these Yates-American Radiators and Intercoolers fill the important job of cooling both the hard-working engines and the air they compress. Yates-American builds quality radiators for motor trucks, industrial trucks, tractors, locomotives, power plants—offers products for every heat transfer use. Give us your requirement . . . we'll show you how we can help you.

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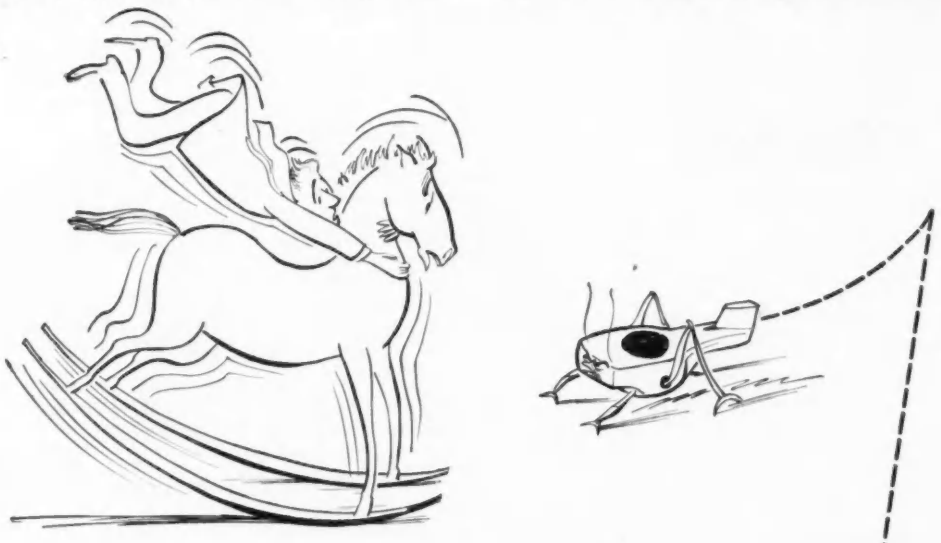

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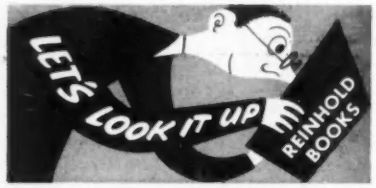

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☐ **INSTRUMENTS FOR MEASUREMENT AND CONTROL** *by Werner G. Holzbock.* Describes and illustrates all recent devices for measuring and controlling temperature, moisture, pressure, flow, uniformity, etc. Discusses the design, construction and operation and comparison factors to consider in choosing the proper instrument for a particular job. 1955, $10.00

☐ **PROTECTIVE COATINGS FOR METALS.** *New 2nd Edition, by R. M. Burns and W. W. Bradley.* Greatly enlarged and almost entirely rewritten, this new edition of Burns' world-famous ACS Monograph contains the latest information on the composition, properties and performance of metallic and organic coatings. Over 640 pages of valuable material concerned with the technology of corrosion control. 1955, $12.00

☐ **BRAZING MANUAL** *by the Committee on Brazing and Soldering, American Welding Society.* Describes the principles, equipment and procedures involved in the 8 major brazing processes; each operation from surface preparation to postbraze inspection; and techniques of brazing aluminum, magnesium, copper, steels, nickel and many other metals. 1955, $4.75

☐ **PLASTICS FOR CORROSION-RESISTANT APPLICATIONS** *by R. B. Seymour and R. H. Steiner.* Shows engineers how to select the right plastic for construction in corrosive atmospheres; the use of plastics as protective coatings, organic linings, chemical resistant mortar cements, casting resins, plastic foams, impregnants, industrial adhesives and reinforced materials. Plastics available for a specific application are compared in tabular form for quick, easy selection of the most suitable material. 1955, $7.50

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☐ **MOTOR OILS AND ENGINE LUBRICATION** *by Carl W. Georgi.* Describes in great detail the methods of testing and evaluating performance characteristics of motor oils. Includes detailed specifications covering various types of engine tests, properties of lubricants (ash, carbon residue, pour point, color, etc.). Covers chemical and physical properties, application of motor oils and the relation of oils and lubrication to engine design, operation, maintenance, breakdowns and failures. 1950, $9.50

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☐ **TOOL ENGINEERS' DATA BOOK** *by G. J. Gruen.* Contains all of the tables, formulas, constants and specifications needed by the practicing tool engineer and designer. Contains amazingly complete data on the heat treatment of special alloys and stainless steels, spot identification of metals, alloys and plastics, and a vast amount of other hard-to-find information. 1953, $5.50

☐ **RESIDUAL STRESSES IN METALS AND METAL CONSTRUCTION** *Edited by W. R. Osgood.* Describes and evaluates the effects of residual stresses upon the performance of various kinds of structures. Covers the origin, magnitude, distribution, etc. of all types of residual stresses existing in a structure or machine arising from welding, machining, or other causes. 1954, $10.00

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Obituaries

Continued from page 122

and factory superintendent. He remained with National Formetal until 1954.

DeKome was an Associate Member of Cleveland Engineering Society.

THOMAS ERWIN DICKS

Thomas E. Dicks, in charge of fleet and contractor sales for Gulf Oil Corp. in the Southeastern area, died Feb. 24, 1956.

Dicks had been associated with Gulf for 35 years. His title has been marketer, fleet and commercial markets. He has maintained offices in Atlanta, Ga.

He was a former chairman of the Georgia Petroleum Industries Committee. He attended Georgia Institute of Technology and Atlanta Law School.

WALTER N. DEISHER

Walter N. Deisher, formerly vice-president and general manager, Avro Canada, Ltd., died Feb. 7, 1956. He remained director and adviser of the aircraft company after his retirement in 1951. He was Avro's general manager from 1945, when the firm was formed, until 1951.

His experience in aviation goes back to the early days of flying. He became a pilot in 1912 and held a license signed by Orville Wright.

In 1929 he was elected chairman of the first national convention of Canadian flying clubs at Ottawa.

He had been a member of SAE since 1917 and was also a member of the Institute of Aeronautical Sciences.

DONALD P. HAHN

Donald P. Hahn, superintendent of maintenance, People's Transport Corp., Muskegon, Mich., has died.

He had been with People's Transport since 1951. Previously, he served Lakeshore Coach Lines, Inc., Detroit; Excello Corp., Detroit; and Clark Engineering Corp. He started as road service manager for Clark Engineering.

JAMES FRANK CHAPMAN

James F. Chapman, development engineer, Flxible Co., Motorcoach, Londonville, Ohio, died Dec. 12, 1955. He had been with Flxible only about two years.

Previously, Chapman had served ACF-Brill Motors Co. as chief experimental engineer. He started with

CONTINUED ON PAGE 126

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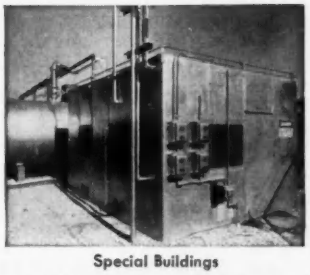

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Obituaries

Continued from page 124

Brill in 1932, when the company was known as J. G. Brill Co.

His first job was with American Car and Foundry Motors Co., for whom he served as an experimental engineer from 1926 to 1932.

Chapman got his BS in Mechanical Engineering from the University of Michigan in 1926.

MARVIN N. SCHNEIDER

Marvin N. Schneider, manufacturers sales representative, Willard Storage Battery Co., died Jan. 26, 1956. He was 38.

Schneider had been serving Willard since 1941. Previous to that he was a serviceman for Morse Signal Devices Co.

He had joined SAE in 1951.

NOLAN J. CLARK

Nolan J. Clark, research metallurgist, Reed Roller Bit Co., Houston, Texas, has died. He had been with Reed Roller Bit since 1926.

Clark received a BS in Chemical Engineering from Rice Institute in 1926. He immediately joined Reed Roller Bit as chief chemist. He became assistant chief metallurgist in 1942 and chief metallurgist in 1946.

He was a Member and Company Sustaining Member of the American Society for Metals. He was also a member of the Houston Chapter of the American Petroleum Institute.

CHARLES GRANT McDOUGALL

Charles G. McDougall, vice-president and secretary, Gransden-Hall & Co., Flint, Mich., died recently.

McDougall joined Gransden-Hall in 1943 to take charge of administration. He became vice-president of the company in 1948 and vice-president and secretary in 1949.

Previous to serving with Gransden-Hall, he was assistant director of purchases for General Motors of Canada, Ltd.

He was also a Sustaining Member of the American Society for Metals.

FLOYD R. RITCHIE

Floyd R. Ritchie, owner and manager of Reo Washington Sales Co., died recently. Reo Washington is the sales company for Reo trucks and buses.

Ritchie had been with Reo Washington since 1949. He started in industry in 1923 as a salesman for Mackinte Motor Truck Corp. His subsequent positions were in the sales departments of Blangy Motor Co., Firestone Service Stores, and Mack Truck Co.

From 1942–1945 Ritchie was district manager for the U. S. Government Office of Defense Transportation.

For more complete information, both on contact materials as well as methods of construction, write for this booklet.

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Electrical contacts, whatever their application, must be well-engineered to insure maximum performance at minimum cost.

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1. CONDUCT MAXIMUM CURRENT. Contact mass, contact surface area and contact backing must be of ample size to conduct current, including peak current, to which they will be subjected.
2. DISSIPATE MAXIMUM HEAT. Inadequate removal of heat greatly increases the electrical resistance, and this, in turn, generates more heat which impairs the current carrying ability.
3. REMAIN SUFFICIENTLY CLEAN so that uniform contact surface resistance will be maintained. Surfaces can be kept smooth and clean by a mechanical rubbing or wiping action or by use of correct contact materials.
4. RESIST STICKING OR WELDING. The mechanism should open contacts as rapidly as possible and with enough force so they will open even under tendencies to stick or weld. Contact materials which minimize sticking are available.
5. RESIST CORROSION in any atmosphere to which they normally may be subjected.
6. WITHSTAND MECHANICAL WEAR. The contacts must be sufficiently hard and durable to withstand even the mechanical wear caused by a rubbing, wiping or hammering action.
7. WITHSTAND ARC EROSION. While arc erosion cannot always be completely eliminated, it can be retarded by use of correct contact materials and also by proper modifications in the electrical and mechanical design of the device.

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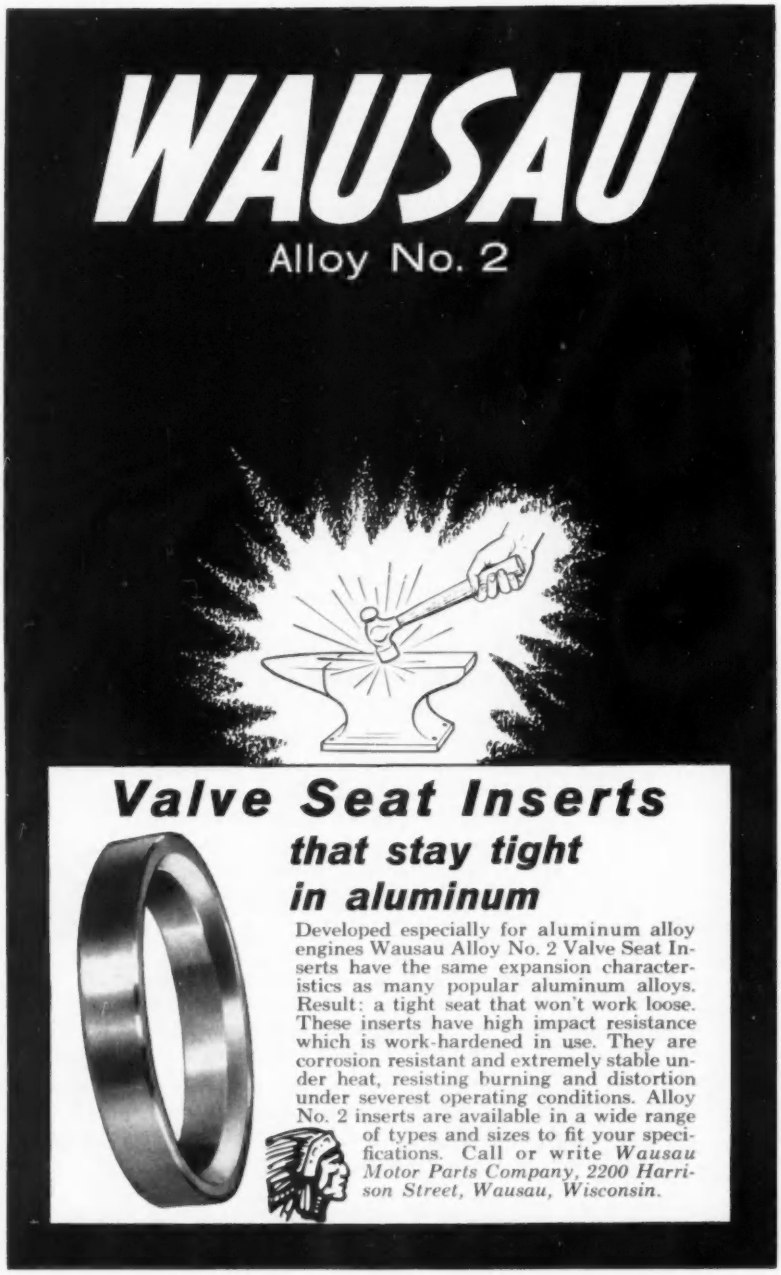
EUROPE is far behind the United States in the development of diesel locomotives, but progress is now rapid, with far-reaching plans for dieselization and more than 70 companies building locomotives and railcars.

Post-war economic conditions have handicapped advances. The desire of countries to purchase equipment within their own territories makes the individual locomotive manufacturer's production small and his unit costs high. A European 800-hp switcher, for example, may cost 30% more than its American equivalent for this reason. Furthermore, there is the obstacle of high interest rates for borrowed money in contrast to our low-rate equipment trust borrowing.

Thus far, diesel locomotive drive has been overwhelmingly electric except for very small units. Now there is found an increasing use of straight mechanical transmissions, hydraulic torque converter drive, or a combination of both.

Engines of the four-cycle turbocharged type predominate. Engine speeds are mainly below 1000 rpm but a strong trend toward higher speeds, such as 1500 rpm, can be detected.

Realization that international standardization would bring great economic advantage has brought a beginning toward unification. First cost would be reduced and operating costs would also be cut if locomotives could cross frontiers without uncoupling. Straight-through runs would bring about better utilization of equipment. (Paper "Present Status of Diesel Locomotives in Europe" was presented at SAE Golden Anniversary Diesel Engine Meeting, St. Louis, Nov. 4, 1955. It is available in full in multilith form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)


WAUSAU
Alloy No. 2
Valve Seat Inserts
that stay tight
in aluminum
Developed especially for aluminum alloy engines Wausau Alloy No. 2 Valve Seat Inserts have the same expansion characteristics as many popular aluminum alloys. Result: a tight seat that won't work loose. These inserts have high impact resistance which is work-hardened in use. They are corrosion resistant and extremely stable under heat, resisting burning and distortion under severest operating conditions. Alloy No. 2 inserts are available in a wide range of types and sizes to fit your specifications. Call or write Wausau Motor Parts Company, 2200 Harrison Street, Wausau, Wisconsin.

Based on Discussion

H. D. Young,
Sinclair Research Laboratories, Inc.

Certain trends noticeable in this country appear to have their counterpart in European practice. Among them are:

1. Renewed interest in railcars for short haul, high density service.
2. Lighter, lower, articulated type of high speed trains.
3. Active interest in hydraulic torque converters for locomotives.

W. L. H. Doyle,
Caterpillar Tractor Co.

Standardization giving locomotives common usage throughout Europe will reduce by 50% the number needed to modernize the railroads. This saving, among others, explains the pressure behind the program for international standardization.

H. Muller,
Shell Oil Co.

At the International Internal Combustion Engine Congress held at the Hague last May, it was considered that the high-speed diesel is quite dependent on the quality of the lube oil. Heavy-duty oils were found to out-perform straight mineral oils. With the introduction of heavy-duty oils, inspection and overhaul periods for pistons could be extended appreciably, while their use was found to increase the economy of operation.

New Members Qualified

These applicants qualified for admission to the Society between March 10, 1956 and April 10, 1956. Grades of membership are: (M) Member; (A) Associate; (J) Junior.

Alberta Group

Brian Caldicott (J), Lathrop B. Flintom, Jr. (A), W. H. Hannam (A).

Atlanta Section

Capt. H. T. E. Tollett, Jr. (M).

Canadian Section

Raymond L. Cavanagh (M), Albert L. De Sadeleer (M), Ernests Groskopfs (J), George G. Macenko (J), Kenneth B. Young (M).

Central Illinois Section

Robert H. Pierce, Jr. (J), William G. Zorn (M).

Chicago Section

John K. Buttfield (J), E. A. Domes, Jr. (J), Vernon D. Enwald (A), John E. Kelly (A), R. J. Siewers (A), Robert J. Smith (M).

Cincinnati Section

J. Douglas Delano, Jr. (M).

Cleveland Section

William D. Adams (A), W. H. Chandler (M), H. H. Deist (M), Paul N. Prass (M).

Dayton Section

Robert E. Beauregard (M), William W. Higham (M), 1st Lt. Paul E. Wilkins (J).

Detroit Section

Dr. G. H. Appel (M), Gustav E. Autenrieth (J), Robert L. Ayers (M), Frederick J. Beamish (A), Alfred P. Blomquist (J), A. C. Breitenbeck (M), R. Thomas Bundorf (J), John R. Burrell, Jr. (J), William S. Carter (J), Julius A. Clauss, Jr. (M), Norman W. Couch (J), Thomas F. Daly, Jr. (M), Arthur P. Dowd (A), Robert J. Dubuc (M), Dr. N. E. Edlefsen (M), Chester W. Everts (M), Garry T. Fortune (J), Gordon T. Getsinger (A), Edward R. Goudberg (A), Charl E. Greene (J), Donald L. Groves (M), LeRoy C. Guthrie (M), James Neil Hall (M), Russell H. Hallman (M), Ivan W. Hansen (A), Clinton F. Hegg (A), Richard E. Hulten (J), William Krass (J), William S. Kristofetz (J), Savas Laskarides (J), Eino A. Leppiaho (M), S. Austin Marquis (A), Bruce McCullough (M), Howard N. McGregor (J), Louis F. Mortenson (M), Richard D. Murphy (J), William O. Murtagh (A), George A. Nahstoll, Jr. (M), Roy E. Peckham (M), Thomas K. Pembleton (J), G. Thomas Poirier (M), Robert C. Redford (M), James Robinson (M), John A. Schaible (M), Sydney Fred Segal (J), William R. Slattery (M), Yunus Unal (A), Philip J. Willson (M), W. B. Wollard (A), Joseph Yuhasz (J).

Indiana Section

Donald J. Hausmann (J), Thomas I. Monroe (M), Glen Alan Smith (J).

Kansas City Section

David W. Berry (M), John M. Van Dam (M).

Metropolitan Section

Alan W. Baum (M), L. Edward Bunch (M), James V. Carideo (A), W. D. Catterson (J), Joachim Herz (J), David C. Nyenhouse (J), Lionel E. Reed (M), Bertram E. Sealander (M), George E. Shevlin (M), Jeffery Lane West (J), Charles Wilde (M), Stephen L. Wythe (M).

WAUSAU
WF-3-0
Sintered Metal
Piston Rings
WF-3-0 is a uniquely different sintered iron alloyed in the powder form so as to permit extremely accurate analysis control when the metal is produced. As a result, rings made from WF-3-0 have greater uniformity and stability, higher tensile strength and high modulus of elasticity. Ring breakage is eliminated, ring life increased and performance greatly improved. In addition, simplified production techniques have resulted in a better ring at lower cost. WF-3-0 rings are especially effective in small bore engines, automatic transmissions, power steering units and similar applications. Call or write
Wausau Motor Parts Company
2200 Harrison Street, Wausau, Wis.

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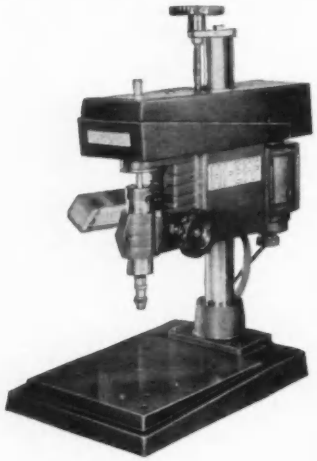
Sensitive Precision Drilling Machines



New! New!

NOW! Taylor HI-EFF offers you a new "C" Series Sensitive Precision Drilling Machine priced *considerably lower* than the well-known "A" Series, yet containing most of the quality features found in the "A" Series machines.
Write for Bulletin 182.

AUTOMATIC FEED NOW AVAILABLE

Automatic Feed attachments for small hole drilling are now available for all Taylor HI-EFF "A" Series and "C" Series machines. Easily Adaptable!

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DYNAMOMETERS • BALANCING MACHINES
DRILLING MACHINES

6411 River Parkway, Dept. SA, Milwaukee 13, Wis.
INTERNATIONAL DIVISION — DUMMANN WORLD TRADE CO., Milwaukee 6, Wisconsin, U. S. A.

New Members Qualified

continued

Mid-Continent Section

C. M. Gordon, Jr. (M).

Mid-Michigan Section

R. Paul Schreiber (M), Robert J. Schultz (J).

Milwaukee Section

James E. Braas (A), James L. Bunda (J), J. W. Jaspersen (A), Robert C. Verhaeghe (M).

Montreal Section

Gilles Beaulieu (J), Roger Bussieres (J), Arnold A. Rackham (M).

New England Section

William J. McIsaac (A), William G. Pursell (A).

Northern California Section

William M. Blair (J), William E. Bliss (M).

Northwest Section

Donald H. Burton (A), G. Ronald Giberson (J).

Oregon Section

Jack M. Ward (A), Norman Cecil Williams (M).

Philadelphia Section

Harlan R. Headley (J).

Pittsburgh Section

Edgar L. Fix (A).

St. Louis Section

Charles Ray Askew (J).

San Diego Section

L. J. Bordelon (M), Henry W. Callihan (M), Ray Ditto (M), Glenn Karel (M), John Marroquin, Jr. (M).

Southern California Section

John Carrigan (J), E. R. Casale (M), Robert H. Hadfield (J), K. V. Lamoreux (A).

Southern New England Section

William M. Letteris (A).

Spokane-Intermountain Section

Leo J. Peot (J).

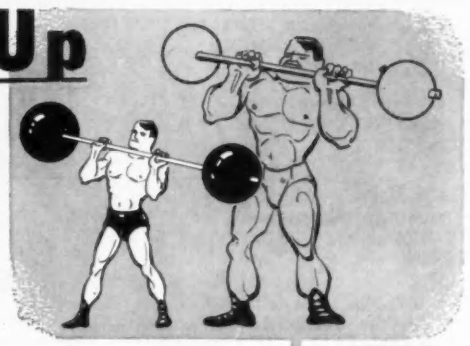
Texas Section

Jack B. Callan (M), Jennings Donell Means (J).

Texas Gulf Coast Section

James A. Ellison (M), Norman P. Geiken (J), T. Noah Smith, Jr. (A).

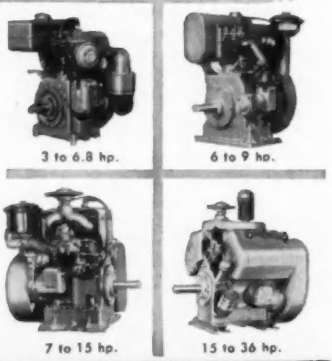
Power-Up your equipment the "Beefless" way



You don't need "beefy" bulk to get brawn . . . nor *size* to insure stamina. Built for the work you want them to do, *sized* to fit your equipment most readily, Wisconsin Heavy-Duty Air-Cooled Engines offer a variety of design and performance advantages.

Every Wisconsin Engine (3 to 36 hp.) has the inbuilt "lug-ability" to slug it out in the roughest company . . . and in this performance, Wisconsin's advanced concept of heavy-duty engineering in a compact power package plays an important role in direct relation to the *design* and *operating* requirements of the original equipment builder.

Bulletin S-188 brings you complete data. Write for it.



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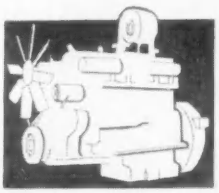
WISCONSIN MOTOR CORPORATION
World's Largest Builders of Heavy-Duty Air-Cooled Engines
MILWAUKEE 46, WISCONSIN

A 8719-½A

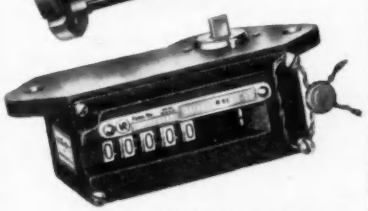


For every engine, there's a VEEDER-ROOT REV-COUNTER

to prove your product's claims

Rev-Counter for general built-in use. Self-contained case is designed for outside application.

Rev-Counter especially designed for installation in user's housing.



Rev-Counter especially designed for built-in installations.

That's right . . . you can build into your engine a real "performance-prover" that keeps a faithful and complete record of engine use . . . a record that's beyond dispute. These Veeder-Root Rev-Counters *show you and your customers,* at any time, exactly how your equipment is performing up to its guarantee . . . whether they're getting out of it all the service you built into it. These direct counter-readings also show at a glance when routine maintenance is coming due . . . whether servicing is needed . . . and supplies other valuable facts-in-figures.

This 2-way protection is vital not only as a built-in feature of engines, but also of generators, compressors, heaters, refrigerators, high-speed cameras, and what have *you?*

Veeder-Root Rev-Counters are available with *tachometer take-off* . . . and may be geared to your own engine requirements. Count on Veeder-Root for any assistance you need in designing these Rev-Counters into your product. Write:

VEEDER-ROOT INC., Hartford 2, Conn.

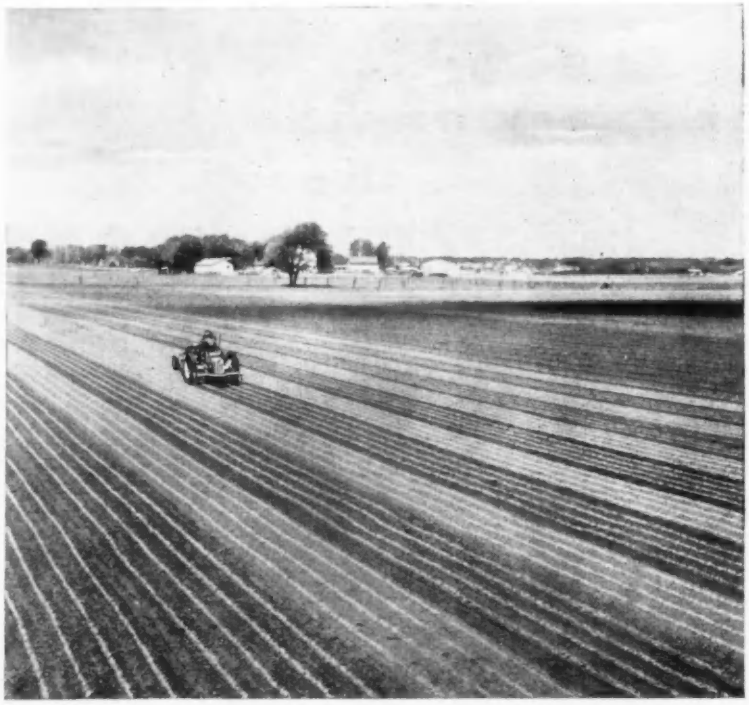
Everyone Can Count on

VEEDER-ROOT

"The Name that Counts"

STOCKS OF STANDARD COUNTERS AVAILABLE AT

Greenville, S. C. • Chicago 6, Ill. • New York 19, N. Y. • Los Angeles • San Francisco • Montreal 2, Canada • Offices and Agents in Other Principal Cities



Yes, we have hayseeds in our hair

You don't ordinarily associate Clark Equipment with the business of farming, but we're in it—and in no small way.

On crop acreages, drainage, fertilizers, feeds and the like, we don't pose as authorities; but in the vital area of power equipment, without which modern farming wouldn't be modern, we know what we're talking about.

• A few years ago an implement manufacturer called us in. Said he, in effect —"We know power-farming, you know power transmission. Work with us to design what a tractor drive unit really ought to be."

• We jumped at that—who wouldn't?

Step 1 was to sweep out the rubbish of traditional thinking; and particularly the old idea that a conventional assembly of engine, transmission and axles on a frame constituted an industrial chassis.

Step 2 was to conceive, test and build an axle-transmission driving unit of truly functional design, stripped of every non-essential ounce of metal. That was done.

This intelligent collaboration seemed to us at the time, still appeals to us now, as the best way we know of to build a better machine: this pooling of a manufacturer's operations experience and Clark's half-century of engineering know-how in the basic field of power transmission.

Interesting sequels to that incident are two:

1. Other manufacturers of agricultural and industrial machinery, always alert for constructive ideas, called in Clark engineers—with equally gratifying results.

2. All those manufacturers are still thoroughly satisfied with their Clark Drive Units—and we are just as satisfied with the business of manufacturing them.

Is there a place at your planning table for Clark's engineering imagination and ingenuity and resourcefulness—for designing a new model or for modernizing a present one? They are yours to command. Let's explore the mutual advantages. A letter will make contact.

CLARK® EQUIPMENT

CLARK EQUIPMENT COMPANY
Automotive Division
Buchanan 5, Michigan

New Members Qualified

continued

Twin City Section

Glenn R. Anderson (M).

Virginia Section

R. C. Hinrichs (J), William I. Ivey, Jr. (A).

Washington Section

Lt. Comdr. Lou Ciarrocca (M), James K. Knaell (J).

Outside Section Territory

William G. Crouch (M), William R. Humes (A), Harold Rees (M), Jerome R. Susag (M), William J. Wright (M).

Foreign

Krishnaswamy Mahadevan (M).

Applications Received

The applications for memberships received between March 10, 1956 and April 10, 1956 are listed below.

Atlanta Section

Asa T. Bearse, Jr., Robert B. Caywood, Charles F. Marschner, Samuel R. Osborne, Robert E. Werder.

British Columbia Section

R. H. Garrett, Gordon M. Kirkham, Patrick H. Martin.

Canadian Section

H. Douglas Culham, James R. McClelland, Joseph E. White.

Central Illinois Section

Roger L. Boggs, Birchard M. Brush, Leo W. Davis, Walter R. Gutzwiller, Richard E. Masters, Russell C. Pulst, Roger A. Siewert, Horace J. Swinland, Gus Waeltz.

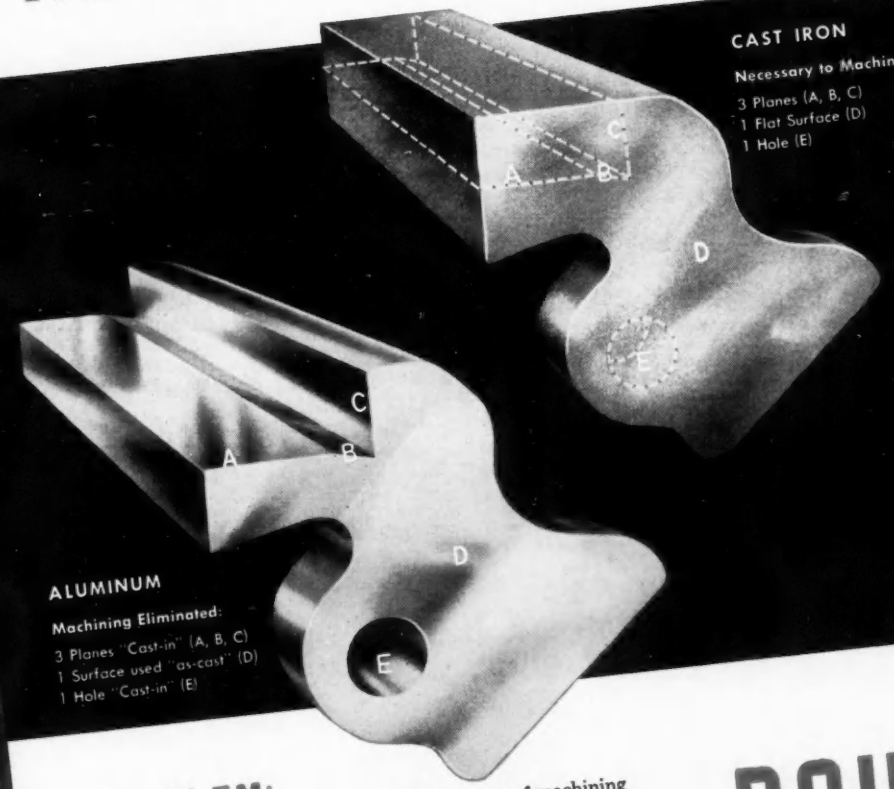
Chicago Section

Harold L. Bowman, Richard L. Durgin, Jerome R. Fornek, George A. Grant, Elmer M. Holtz, Bernard G. Miller, Oliver W. Misel, Raymond C. Nelson, Charles Pacola, Frederick W. Pringle, Frank J. Senese, Noel S. Siegel, Malcolm A. Sime, Samuel R. Stiefel.

Cleveland Section

G. H. Bancroft, Benjamin Barish, Coyt Richard Halverstadt, John G. Helleis, C. A. Hulsemann, Donald J. Kreml, James A. McArthur, Frederic W. Mellor, Jr., Robert C. Ochs, Howard

The Case of the Costly Casting



PROBLEM:
A manufacturer recently found the cost of machining a certain cast iron part had become prohibitive. How could costs be reduced?

SOLUTION:
Investigation showed aluminum permanent mold castings of the same shape would reduce machining time about 10%. But Bohn engineers went several steps further. Working closely with the manufacturer, they re-engineered the job and re-designed the cast shape. This eliminated five machining operations.

RESULT:
Machining time was reduced 80%.

BOHN
ALUMINUM & BRASS CORPORATION
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DETROIT 26, MICHIGAN

Since this ad last ran . . .

A year ago, the above ad told how Bohn engineers helped a manufacturer reduce machining time 80% on one part. Since then Bohn has helped reduce his costs even more. Through familiarity with the part's function in the end product, Bohn engineers suggested redesign improvements. Pilot testing by the customer's Engineering Department, proved the soundness of the design. Result: the actual cost of the part was further reduced 10%.

BOHN

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CASTINGS • FORGINGS • PISTONS • BEARINGS • BRASS ROD • BRASS AND BRONZE INGOTS • REFRIGERATION AND AIR CONDITIONING PRODUCTS • EXTRUSIONS

Applications Received

continued

Peeples, Arthur T. Reeves, Harry M. Valentine.

Colorado Group

Alton S. Jones, Floyd P. Mercure.

Dayton Section

J. S. Sampselle, James L. Tunney, Jr.

Detroit Section

Robert D. Aldrich, Roy L. Bailey, Walter C. Beyer, Raymond Bulmanski, Neil W. Carnell, Philip E. Cartwright, Clifford C. Christiansen, C. Richard Clauson, George W. Craig, Ralph Dean, Jr., Miles G. Doolittle, Alfred W. Duff, Ferdinand R. Eichner, Alfred H. Erwin, Ronald A. Featherstone, Russell J. Fertitta, Charles B. Fleischmann, Paul E. Garrison, William A. Gartland, Anthony J. Gicius, Harold P. Gonyea, Hans M. Hierta, Frank B. Holmes, Eugene G. Humpal, Edwin W. Hurd, John Raymond Jackson, John E. James, Richard I. Jones, Charles L. Knighton, Rudolph N. Krieter, James R. Lee, Po-Lung Liang, Erwin A. Long, Richard D. MacFarlane, John W. McDermott, Earl W. Meyer, Jr., Fay J. Miller, W. J. Moriarty, George M. Nampa, Warren B. Oakley, Jr., Ugo Padovini, Charles B. Pinkstaff, Richard M. Powers, Emil A. Pulick, Jr., Richard A. Randall, John E. Schramm, Richard S. Schuster, John J. Sellman, Robert C. Shaffer, John P. Simmons, William P. Strong, Gerald J. Tobias, Terrance N. Todd, Charles F. Trapp, Jr., Wesley S. Trindal, William L. Weber, Kenneth J. Whitledge, Jack L. Wise, Fred B. Yahrling, Jr.

Hawaii Section

John Andrade, Jr., Frederick Bolte, John M. Ross.

Indiana Section

Gerald J. Hamilton, Joseph E. Kashnik, R. Donald Letsinger, Robert D. McClintic, Spencer H. Mieras, Max L. Moser, Robert R. Roepke, Clayton L. Smith, Ray D. Steward.

Kansas City Section

George F. Dixon, Jr., Perry Hunter, Jr., Surendrakumar P. Patel, Philip W. Wilson.

Metropolitan Section

Francis C. Dupre, E. Boykin Hartley, John B. Hoglund, Yoshiro Ito, Peter M. Margules, William F. Morgan, Christian M. Nielsen, Alexander H. Raye, Arnold Shanzer, Bernard H. Spitalnick, Louis W. Stone, Lionel E. Trotman, Robert A. Wachtler, Herbert Raymond Welsh, Rajih M. Yusuf.

Mid-Michigan Section

John A. Alfes, Mathias F. Brejcha, Earl H. Hogsten, Joseph W. Quinlan, John F. Teigland.

Milwaukee Section

James J. Gibbons, Walter P. LaForce, Albert Manna, Henry M. Mills, Donald E. Niles, Francis H. Reindl, Roger L. Schluter, Jack N. Yetter.

Montreal Section

Shepperson P. Adkins, William V. S. Rigby.

New England Section

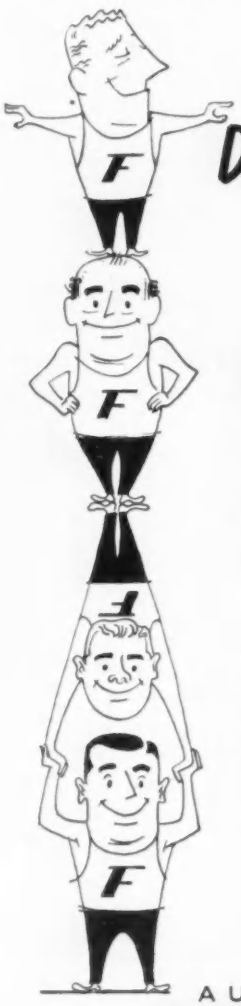
Raymond P. Beaulieu, Harvey G. Clauson, Jr., T. Clark Perkins.

Northern California Section

J. C. Gudgel, Sr., Dean Schallen.

Northwest Section

Calvin W. Townsend, Jr.



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when dependability counts!

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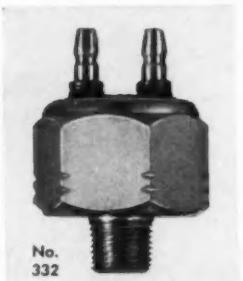

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Ex-Cell-O Precision Cylinder Boring Machines shown below are finish-boring V-8 engine blocks. Like so many other high-production machines, these make generous use of hydraulics.

In addition to the advantages inherent in hydraulic control, Vickers Hydraulics gives you the benefits of a nation-wide company-operated field engineering and service organization to assure correct application and operation with least maintenance. Vickers has the complete line of hydraulic equipment necessary to take undivided system responsibility . . . to eliminate any risk of incompatibility of hydraulic components.

The Vickers Application Engineer near you will be glad to demonstrate the many benefits you can obtain by using Vickers Hydraulics. Write for a copy of Catalog 5002B.

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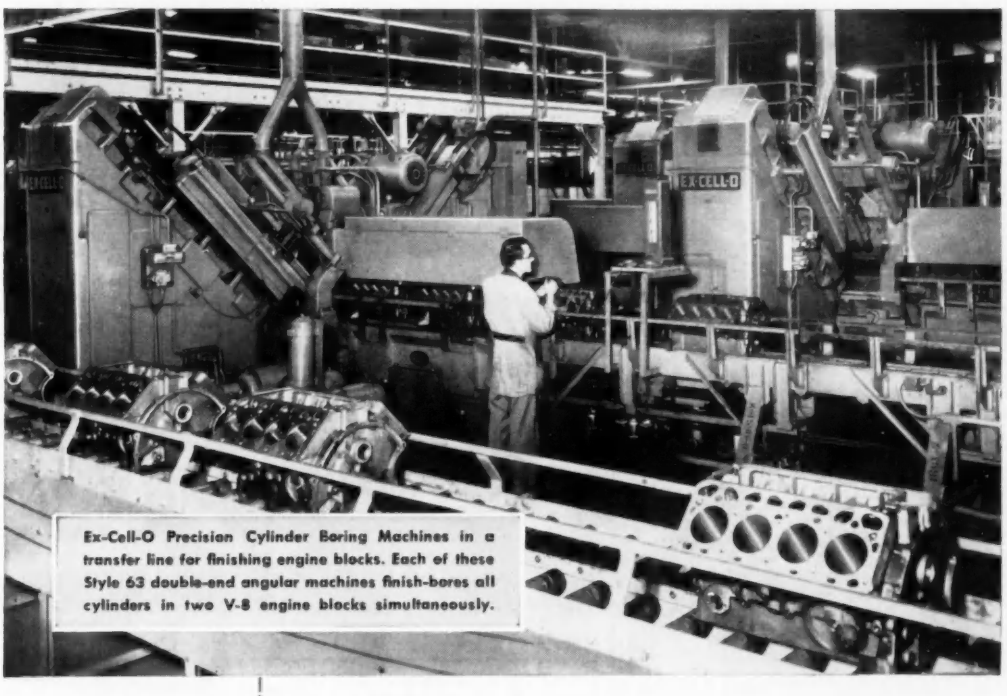
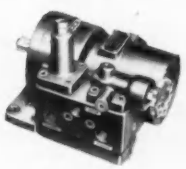
IN CANADA: Vickers-Sperry of Canada, Ltd., Toronto

Engineers and Builders of Oil Hydraulic Equipment Since 1921



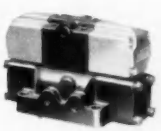
Ex-Cell-O Precision Cylinder Boring Machines in a transfer line for finishing engine blocks. Each of these Style 63 double-end angular machines finish-bores all cylinders in two V-8 engine blocks simultaneously.

Representative VICKERS Units Used on Ex-Cell-O Precision Cylinder Boring Machines



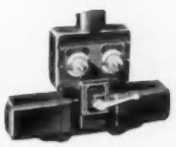
Two-Pressure Pump

Insures lower maintenance cost and saves horsepower and heat in two-pressure hydraulic circuit. Automatically provides high volume at low pressure and low volume at high pressure.



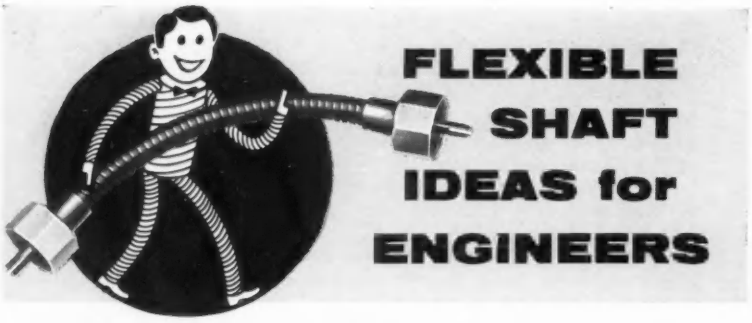
Solenoid Controlled Pilot Operated 4-Way Valve

Compact and versatile "sandwich" construction. Gasket mounting simplifies installation and overhaul . . . also minimizes piping.



Traverse and Feed Cycle Control Panel

Maintains smooth and constant preset feed rate regardless of fluctuations in cutting tool resistance or hydraulic pressure.



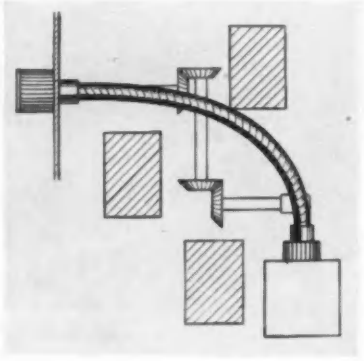
One part does the work of many when you use a flexible shaft

Design simplification is one of the reasons why it pays to use S.S.White "Metal Muscles"®

IT'S A DESIGNER'S AXIOM that simplification is one of the most effective ways of reducing product costs. By so doing, you save weight, you eliminate a number of unnecessary parts and you reduce assembly time and costs.

Eliminating Parts

When it's a question of transmitting rotary power or providing remote control, especially where turns or alignment are involved, an S.S. White flexible shaft is an efficient cost-saving solution. The illustration below demonstrates why this is so.



One flexible shaft is all it takes to do a job that might otherwise require an entire system of bevel gears, straight shafts, universals, etc. Added to this is the fact that installation is greatly simplified and alignment problems are eliminated.

90% Cost Reduction

Actual cost figures on a control set-up for a large dual hydraulic power system dramatize how effectively flexible shaft simplification can cut costs.

In this case, 35 parts including universal rods and bevel geared elbows were being used to transmit control from two handwheels to a motor control unit and thence to two hydraulic motors.

Without any necessity of redesigning the equipment, 4 standard S.S.White flexible shafts were used in place of the original control system. The result was a 90% savings — and, incidentally, 100% improved performance.

What About Your Application?

Perhaps your own designs cannot realize benefits as outstanding as this. But the chances are good indeed, that, if you are not now using them, you'll be able to handle many remote control and power drive applications better and at less cost with an S.S.White flexible shaft.

USEFUL FLEXIBLE SHAFT DATA

Bulletin 5601 has concise information on how to select and apply flexible shafts. Send for a copy.

F6-2

S.S.White FIRST NAME IN FLEXIBLE SHAFTS

S. S. WHITE INDUSTRIAL DIVISION, DEPT. J, 10 EAST 40th ST., NEW YORK 16, N.Y.
Western Office: 1839 West Pico Blvd., Los Angeles 6, Calif.

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BENDIX-WESTINGHOUSE AIR BRAKES— Best buy for your trucks because they're preferred by America's Leading Fleet Operators!

"We've bought 1,333 trucks AND WHEN IT COMES TO AIR BRAKES, WE PREFER Bendix-Westinghouse!"

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MR. R. A. GOODLING
President, Dixie Highway Express, Inc.

From his company's general headquarters in Meridian, Mississippi, Mr. Goodling, newly elected national chairman of the Common Carrier Conference, American Trucking Association, directs one of the nation's most safety-conscious fleet operations. Serving points in Mississippi, Georgia, Alabama and Louisiana, this company in 1953-54 won the National Safety Award in the ten to twenty million mile group of the general commodity class. Dixie Highway Express, Inc., employs over 750 people, maintains 13 terminals and operates on certified routes totaling nearly 1,500 miles.

"We've bought 2,600 trucks AND WHEN IT COMES TO AIR BRAKES, WE PREFER Bendix-Westinghouse!"

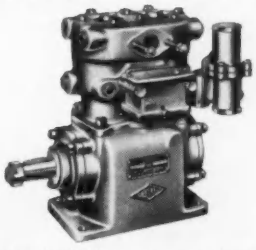
THE WORLD'S MOST TRIED AND TRUSTED AIR BRAKES

MR. C. BERTRAM HOFFBERGER
President, Baltimore Transfer Company and Motor Freight Express, Inc.

The Baltimore Transfer Company and Motor Freight Express, Inc., with general offices at Baltimore, Maryland and York, Pennsylvania, integrate operations so as to form a motor carrier system serving the major portion of the Middle Atlantic States. These companies employ over 1400 people and have a combined fleet of better than 1000 vehicles. The system has fourteen terminals in Pennsylvania, New Jersey, Maryland, Washington and Virginia and handles over a million individual shipments a year.

For twenty-five years Bendix-Westinghouse Air Brakes have been the first choice of truck manufacturers and truck operators everywhere, consistently outselling all other makes of air brakes combined. In fact, recognition of the greater safety, economy and dependability of Bendix-Westinghouse Air Brakes by truck buyers has resulted in their factory installation on an ever increasing number of truck models of all sizes.

Chances are good that your trucks, too, offer the many advantages of these powerful brakes. If not, we suggest that you take advantage of the proven preference and superiority of Bendix-Westinghouse Air Brakes by offering them as factory-installed equipment. It's one sure and easy way to add more sales appeal to your vehicles!



Over 1,500,000 compressors, produced over a twenty-five-year span, stand behind the TU-FLO 400. Many advanced features guarantee performance no other compressor can equal.

Bendix-Westinghouse BENDIX-WESTINGHOUSE AIR BRAKES® **AIR BRAKES**

BENDIX-WESTINGHOUSE AUTOMOTIVE AIR BRAKE COMPANY • General Offices and Factory—Elyria, Ohio. Branches—Berkeley, Calif. and Oklahoma City, Okla.

NEW

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ESPECIALLY DESIGNED FOR TOP RING GROOVE PROTECTION IN PISTONS FOR GASOLINE ENGINES

AN ECONOMICAL METHOD WITH MINIMUM WEIGHT INCREASE

CAN BE APPLIED TO ANY TYPE ALUMINUM ALLOY PISTON

PERMA-GROOVE*

WITH SEGMENTAL STEEL TOP RING SECTION

TOP RING SECTION

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OUTSTANDING ADVANTAGES OF ZOLLNER "PERMA-GROOVE" TOP RING SECTION

1. Individual steel segments eliminate continuous band expansion problem.
2. Segments securely locked to prevent radial movement.
3. Dovetailed edges keep steel segments securely in plane with groove.
4. 75% steel bearing area for wear resistance.
5. 25% aluminum bearing area for heat conductivity and cool operation.
6. Light in weight.

Again, Zollner engineering leadership provides another great piston development to engine builders. The new Zollner "Perma-Groove" gives sensationally longer life to pistons and rings, prevents blow-by, minimizes oil consumption. The light weight segmental steel section incorporates high wear resistance in the top ring groove *plus* the advantage of cool operation. Designed especially for gasoline engine pistons, "Perma-Groove" is the quality, low-weight and low-cost companion to the popular "Bond-O-Loc" piston for Diesel engines. We suggest an immediate test of "Perma-Groove" advantages for your gasoline engine.

*T. M. Reg. Pat. App. For

ADVANCED ENGINEERING

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COOPERATION WITH ENGINE BUILDERS

ZOLLNER PISTONS

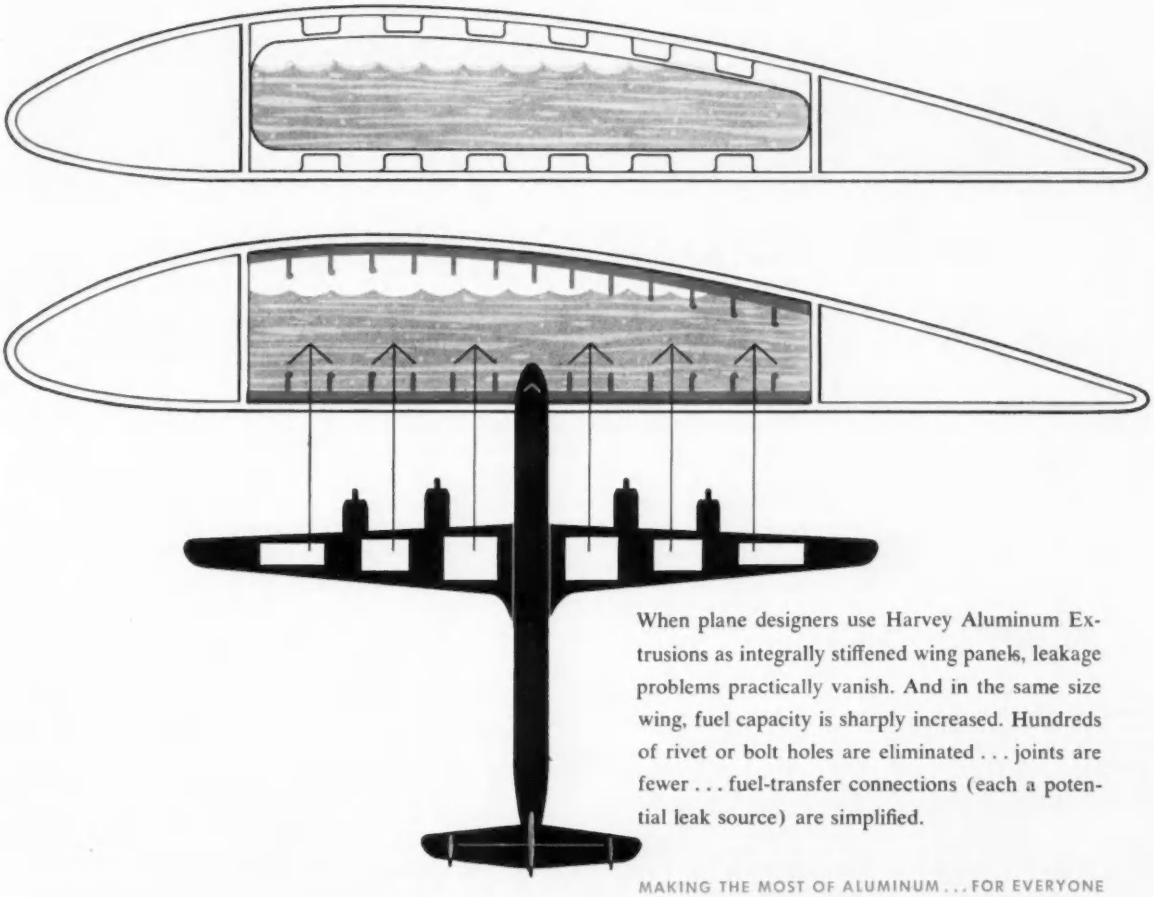
THE ORIGINAL EQUIPMENT PISTONS

ZOLLNER

ZOLLNER CORPORATION • Fort Wayne, Indiana

Harvey extrusions... for safer flight, greater fuel capacity, simpler construction

Fuel leakage in aircraft wing tanks *must* be eliminated at all costs . . . it's one of flying's greatest dangers. Manufacturers once had to resort to elaborate sealing procedures around every joint and rivet. But even then, normal flight operations and wing flexing would eventually cause leaks, and locating them was a giant-sized maintenance headache.



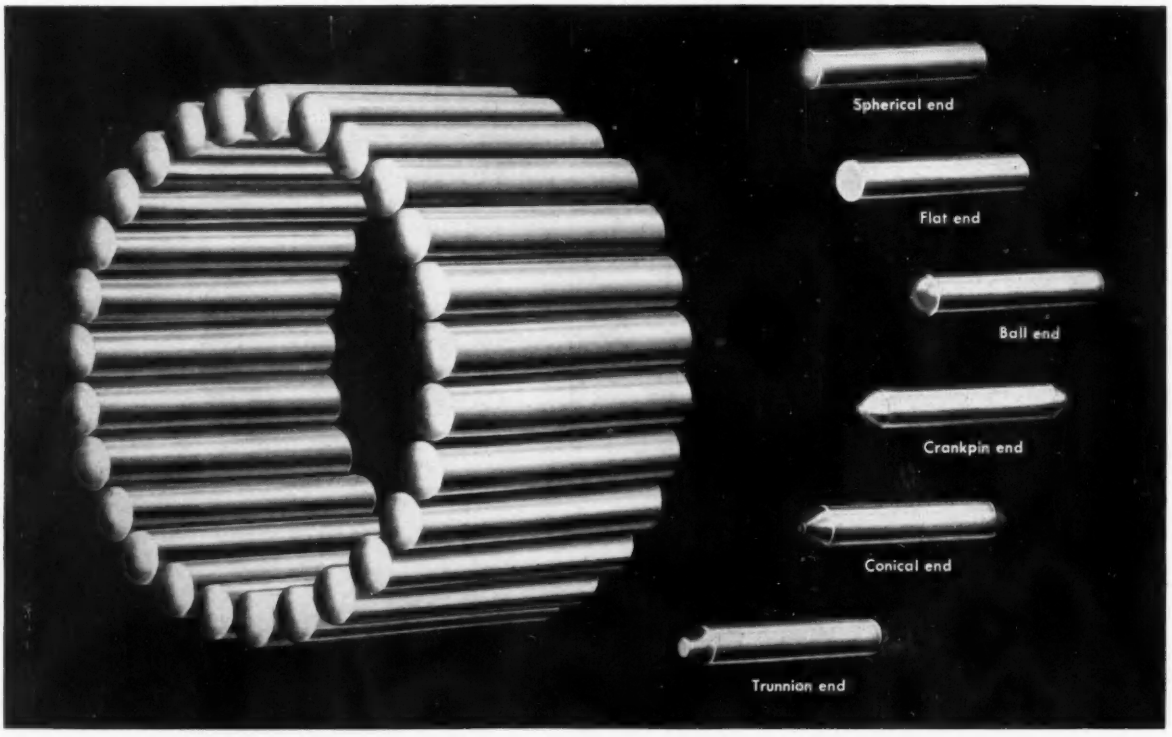
When plane designers use Harvey Aluminum Extrusions as integrally stiffened wing panels, leakage problems practically vanish. And in the same size wing, fuel capacity is sharply increased. Hundreds of rivet or bolt holes are eliminated . . . joints are fewer . . . fuel-transfer connections (each a potential leak source) are simplified.

MAKING THE MOST OF ALUMINUM . . . FOR EVERYONE

HARVEY Aluminum

Harvey is a leading independent producer of aluminum extrusions in all alloys and all sizes, special extrusions, press forgings, hollow sections, structurals, rod and bar, forging stock, pipe, tube, impact extrusions, aluminum screw machine products and related products. Also similar products in alloy steel and titanium on application.

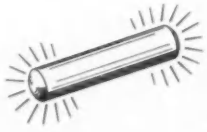
HARVEY ALUMINUM SALES, INC., TORRANCE, CALIFORNIA—BRANCH OFFICES IN PRINCIPAL CITIES



TORRINGTON Needle Rollers

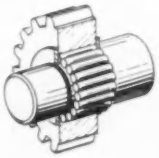
for the ultimate in load capacity at low cost

High radial capacity in minimum space stems from full complement of small-diameter rollers. Load zone contains maximum number of contact lines.



High carbon chrome steel is carefully hardened, ground and lapped to make each Needle Roller a precision part for long-life performance.

Close tolerances on Needle Rollers are assured by stringent quality controls. Standard OD tolerance is .0002" but rollers can be supplied with OD tolerance of .00005." Tolerance on length dimension depends on end formation.



Mounted without races between hardened shaft and hardened housing (RC-60 recommended), Needle Rollers allow largest possible shaft diameters.

Fine finish contributes to efficient anti-friction performance. Needle Rollers are usually polished to 4-6 rms, but finishes as fine as 1-3 are available on special order.

Torrington Needle Rollers provide the lowest cost, highest capacity anti-friction bearings obtainable. They are manufactured in a complete line to meet SAE and AFBMA specifications. Available in the inexpensive spherical end type or in other end shapes, they provide maximum retainment and fillet clearances or greater lip retainment. Needle Roller standards for material, heat treat, tolerance and finish are the highest in the industry.

Good operating results with Needle Rollers require careful design of mating parts furnished by the user. The Engineering Department of The Torrington Company, with broad experience in applications of Needle Rollers, will be glad to give you technical advice on your needs.

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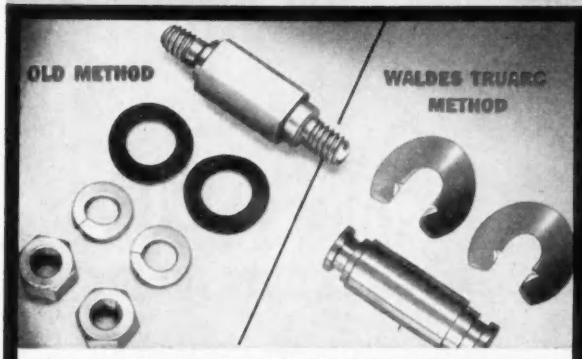
TORRINGTON BEARINGS

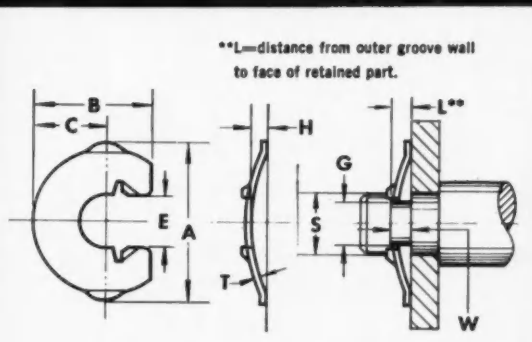
90th ANNIVERSARY 1866–1956

Needle • Spherical Roller • Tapered Roller • Cylindrical Roller • Ball • Needle Rollers

New Waldes Truarc locking-prong ring functions as spring, shoulder, fastener... and STAYS PUT!



Above assembly shows how 2 Waldes Truarc Locking-Prong Rings (Series 5139) replaced 6 parts... eliminated threading operation... and need for skilled labor.



WALDES TRUARC LOCKING-PRONG RING (Series 5139)
U. S. Pat. Pending

Ring No. 5139-	SHAFT Dia. S	SHAFT tol.	RING DIMENSIONS A	tol.	B	tol.	C	tol.	E	tol.	H	tol.	T†	tol.†	average ultimate shear strength lbs.*	GROOVE DIMENSIONS Dia. G	tol.	Width W	tol. −.000	L min.	L max.	resilient end play take up L max−L min
12	.125	±.002	.340	±.010	.307	±.010	.166	±.005	.086	±.004	.050	±.010	.010	±.0013	400	.082	±.0015	.045	+.005	.035	.045	.010
★15	.156	±.003	.380	±.010	.330	±.010	.184	±.005	.108	±.004	.055	±.010	.010	±.0013	600	.104	±.002	.050	+.005	.035	.045	.010
18	.188	±.003	.445	±.010	.390	±.010	.213	±.005	.130	±.005	.060	±.010	.015	±.0015	900	.124	±.002	.065	+.005	.045	.055	.010
25	.250	±.003	.581	±.010	.500	±.010	.280	±.005	.172	±.005	.070	±.010	.015	±.0015	1000	.165	±.002	.070	+.005	.050	.065	.015
31	.312	±.003	.744	±.010	.620	±.010	.360	±.005	.234	±.005	.095	±.010	.018	+.001 −.002	1300	.228	±.003	.080	+.005	.080	.095	.015
★37	.375	±.003	.853	±.015	.740	±.010	.427	±.005	.280	±.005	.130	±.010	.020	±.002	1900	.270	±.003	.105	+.005	.090	.115	.025
★43	.438	±.003	.960	±.020	.820	±.020	.475	±.010	.327	±.010	.130	±.010	.020	±.002	2200	.327	±.003	.105	+.005	.095	.120	.025

Additional Sizes Under Development ★Production dies not available as of date of printing †Applies to unplated rings only *Recommended safety factor =3 to 4.

The Waldes Truarc Locking-Prong Retaining Ring is a new, low cost, radially applied fastener which can be locked positively in its groove and used as a shoulder against rotating parts. It is primarily intended for use in the automotive, electronic and aeronautical industries.

This radially applied ring locks positively in its grooves by means of two prongs at the open end. Because of its high thrust-load capacity the Waldes Truarc Locking-Prong Ring may be used as a shoulder against rotating parts. Its bowed construction provides for end-play take-up in the assembly and makes less critical the tolerances required for the parts being fastened. Since it serves as a spring as well as a shoulder, this ring eliminates the need for springs, washers, and other accessory fastening devices.

Whatever you make, there's a Waldes Truarc Retaining Ring designed to improve your product... to save you material, machining and labor costs. They're quick and easy to assemble and disassemble, and they do a better job of holding parts together. Truarc rings are precision engineered and precision made, quality controlled from raw material to finished ring.

36 functionally different types... as many as 97 different sizes within a type... 5 metal specifications and 14 different finishes. Truarc rings are available from 90 stocking points throughout the U. S. A. and Canada.

More than 30 engineering-minded factory representatives and 700 field men are available to you on call. Send us your blueprints today... let our Truarc engineers help you solve design, assembly and production problems... without obligation.

SEND FOR FREE SAMPLES

WALDES TRUARC® RETAINING RINGS

Waldes Kohinoor, Inc., 47-16 Austel Place, L.I.C. 1, N.Y.

☐ Please send me sample Locking-Prong Rings. (please specify shaft size_____)

☐ Please send me supplement No. 1 which brings Truarc Catalog RR 9-52 up to date.

(Please print)

Name_____

Title_____

Company_____

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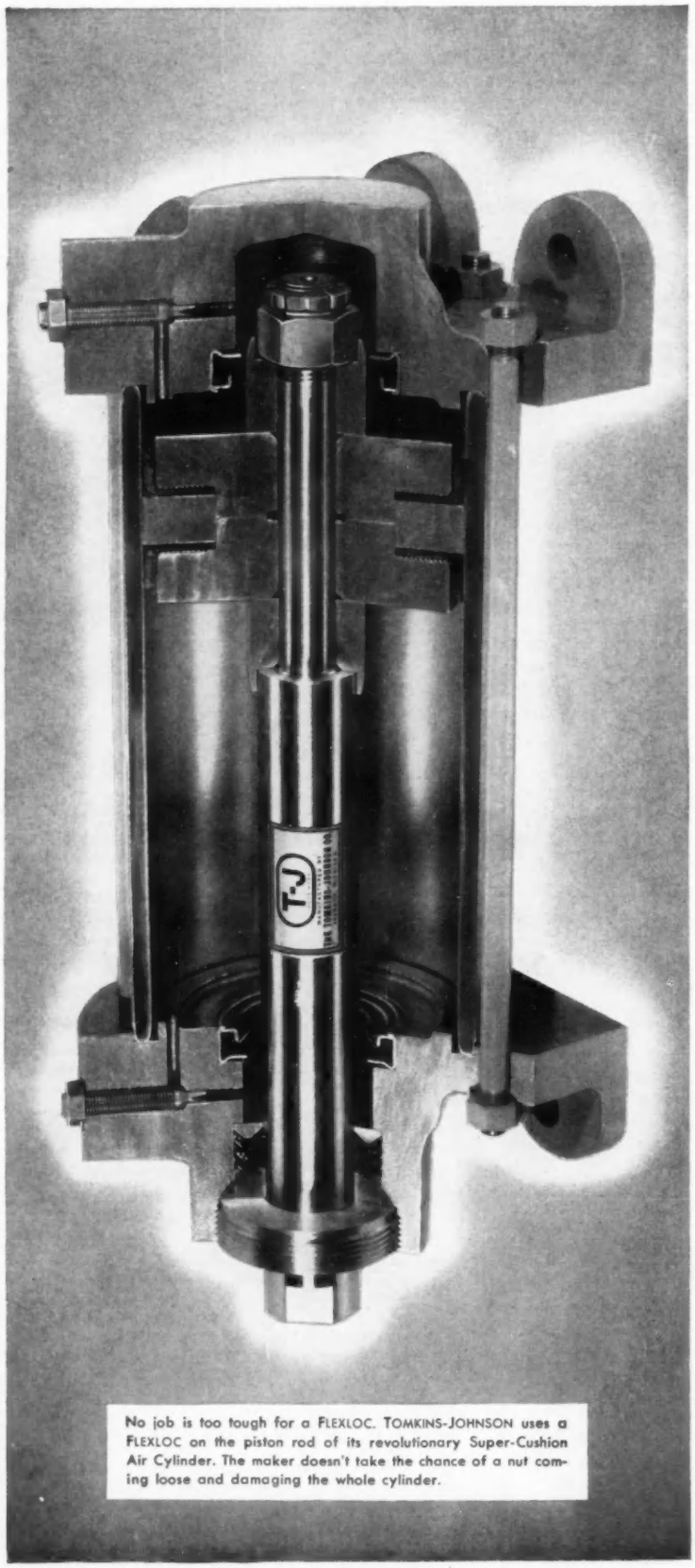
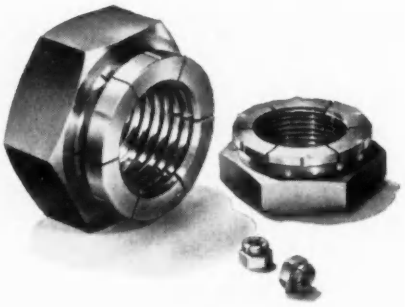
City_____ Zone_____ State_____

SA058

WALDES TRUARC Retaining Rings, Grooving Tools, Pliers, Applicators and Dispensers are protected by one or more of the following U. S. Patents: 2,382,948; 2,411,426; 2,411,761; 2,416,852; 2,420,921; 2,428,341; 2,439,785; 2,441,846; 2,455,165; 2,483,379; 2,483,380; 2,483,383; 2,487,802; 2,487,803; 2,491,306; 2,491,310; 2,509,081; 2,544,631; 2,546,616; 2,547,263; 2,558,704; 2,574,034; 2,577,319; 2,595,787, and other U. S. Patents pending. Equal patent protection established in foreign countries.



No job is too tough for a FLEXLOC. TOMKINS-JOHNSON uses a FLEXLOC on the piston rod of its revolutionary Super-Cushion Air Cylinder. The maker doesn't take the chance of a nut coming loose and damaging the whole cylinder.



What FLEXLOC locknuts do for you

FLEXLOCs eliminate complicated, time-consuming methods of locking threaded fasteners. They offer simpler, faster application and safer, more dependable locking than plain nuts and lockwashers, castellated nuts and cotter pins, or nuts and jam nuts. And they won't work loose.

The reasons for all this are plain. FLEXLOCs are one piece—nothing to assemble, come apart, lose or forget. FLEXLOCs are all metal—have higher tensile than most other locknuts and are not affected by temperatures to 550°F. FLEXLOCs are both stop and locknuts—don't have to seat to lock, and stay put anywhere on a threaded member as soon as their locking threads are fully engaged.

SPS can deliver any quantity of FLEXLOCs in a wide range of sizes. Stocks are carried by industrial distributors everywhere. Write for literature. SPS, Jenkintown 55, Pa.

FLEXLOC®

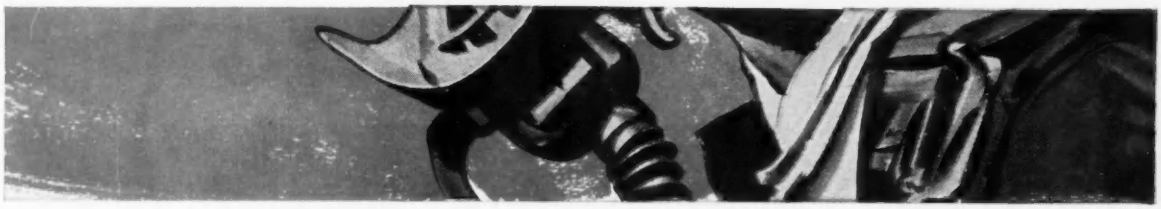
LOCKNUT DIVISION

STANDARD PRESSED STEEL CO.

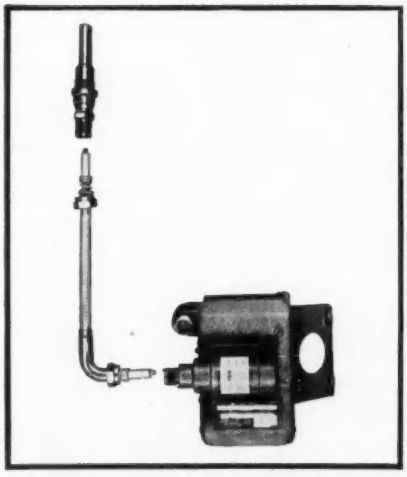
SPS

JENKINTOWN PENNSYLVANIA

Bendix Leading Producer of Aviation Ignition



Presents the latest and best in JET IGNITION



Only Bendix provides the complete ignition system for jet engines—Ignition Unit, Igniter Plug Leads, Igniter Plugs and Control Harness.

It is only natural that the world's leading builders of jet engines should look to Bendix* as the logical source of the latest and best in jet ignition.

For Bendix—and only Bendix—has, since the early days of aviation, specialized in the development of every type of ignition to meet constantly changing, higher-performance flight requirements.

Thus, to the solution of today's problems in jet ignition, Bendix brings unparalleled experience in research, engineering, manufacturing and service. From blue print stage to field service follow-through, you can depend on Bendix—the most trusted name in ignition—for the best in jet ignition for today's planes or tomorrow's plans. *TRADE-MARK

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Bendix
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R. O. Youngberg (left), Project Department Engineer; J. F. Vinson (center), Designer Engineer, and J. M. Swartz, Structures Design Group Engineer, discuss installation problems associated with a coordinate converter of a new missile electronic system.

MISSILES...THE IDEAL FIELD FOR DESIGNERS

Missile systems design gives Designers the ideal outlet for creative and inventive expression.

Here the Designer works in a growing area where the greatest advances in design are being achieved, an area receiving ever increasing emphasis.

Under Lockheed Missile Systems Division's design policy, Designers receive the broadest possible technical background. Varied assignments, covering structures, controls, hydraulics, pneumatics, electromechanical packaging, fuel systems and related areas, give Designers a thorough grasp of all phases of missile design. Nor is the Designer restricted to conventional approaches in his assignments; new design ideas are welcomed. Moreover, the Designer is kept constantly abreast of the progress of his project.

Through this policy, Designers acquire the technical background so necessary for successful missile design.

Those able to contribute to a design effort of the utmost importance are invited to write. Address inquiries to the Research and Engineering Staff at Van Nuys.

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VAN NUYS • PALO ALTO • SUNNYVALE • CALIFORNIA

a new development in powdered metals

Quali-SINT is the latest addition to the extensive manufacturing facilities of Burgess-Norton, producers of precision parts for industry for over 50 years. The development of Quali-SINT is the result of an intensive program of research and production, and represents the highest degree of sintered metal skill commercially possible. This superior quality is produced by teaming the most advanced materials, methods and equipment with the highly developed Burgess-Norton system of quality control.

What *Quali-SINT* means to industry

GREATER STRENGTH

Basic minimum tensile for Quali-SINT parts is 50,000 psi and minimum density is 6.2 g/cc. This greater strength permits a much broader use of Quali-SINT parts than ordinary sintered metal parts.

GREATER UNIFORMITY

Exclusive B-N controls in tooling, blending, compacting, sintering and inspection provide unmatched uniformity in both structure and dimension...from part-to-part and run-to-run.

LOWER FINAL COSTS

The closer tolerances and rigid adherence to specifications cut costs by reducing or completely eliminating many subsequent operations such as machining, cleaning and inspection at the user's plant.

SEND for this informative brochure on

Quali-SINT

another development in precision parts production by

BURGESS-NORTON
Mfg. Co. Geneva, Illinois

THE NEW Spicer THORNTON POWR-LOK WHERE IT IS NEEDED

The new Thornton POWR-LOK for Spicer Axles permits vehicles to operate *even though one driving wheel may be on a low-tractive surface* such as ice, snow, mud, sand, etc.

With the Spicer Thornton POWR-LOK, up to 80% of the vehicle's available power is directed to the wheel with traction under any road surface condition. This is another exclusive Spicer development, offered to you only in Spicer Axles as original equipment for passenger cars, and light and medium-duty commercial vehicles.

The mechanical principles in the Thornton POWR-LOK Differential

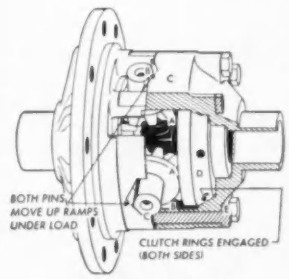


Fig. 1

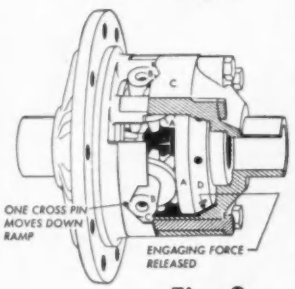


Fig. 2

In the Thornton POWR-LOK, the torque is transmitted from the differential case to the cross pins and differential pinions to the side gears in the same manner as torque is applied in the conventional differential.

The driving force moves the cross pins B (see fig. 1) up the ramp of the cam surfaces C, applying a load to the clutch rings D and restricts turning of the differential through the friction clutches E. This provides a torque ratio between the axle shafts which is based on the amount of friction in the differential and the amount of load that is being applied to the differential.

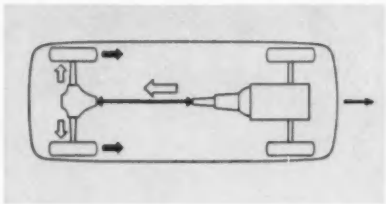
When turning a corner, this process is in effect partially reversed. The differential gears become a planetary gear set, with the gear on the inside of the curve becoming the fixed gear of the planetary. The outer gear of the planetary over runs as the outside wheel on the curve has a further distance to travel. With the outer gear over-running and the inner gear fixed, the pinion mates A (see fig. 2) are caused to rotate, but inasmuch as they are restricted by the fixed gear, they first must move pinion mate shafts B back down the cam surface C relieving the thrust loads on the cone clutches E. Thus when turning the corner, the differential, for all practical purposes, is similar to a conventional differential and the wheels are free to rotate at different speeds.

The engagement of the clutches in the Thornton differential provides many features in this unit that are not common in other types of locking differentials. On straight driving, the clutches are engaged and thus prevent momentary spinning of the wheels when leaving the road or when encountering poor traction. In turning a corner, the load is relieved from the clutch surfaces so that wear is reduced to a minimum.

DANA CORPORATION • TOLEDO 1, OHIO

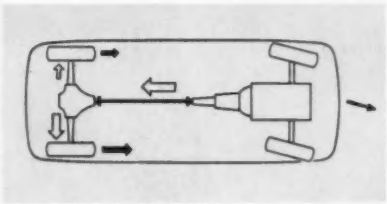
DIFFERENTIAL PUTS PULLING POWER WHEN IT IS NEEDED!

How the Thornton POWR-LOK Differential works in typical driving situations



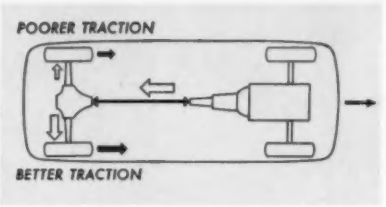
Power Flow in Forward Driving

In normal *forward* driving, the power flow in both the POWR-LOK and conventional differential is transmitted equally to each axle shaft and wheel. However, when one wheel suddenly loses traction on loose or slick surfaces, the POWR-LOK prevents this wheel from spinning, gaining momentum, and swerving the vehicle when good pavement is regained.



Power Flow in Turns

In turning, the POWR-LOK Differential gives normal differential action and permits the outer wheel to turn faster than the inner wheel. At the same time the POWR-LOK differential applies the major driving force to the inside rear wheel, improving stability and cornering.

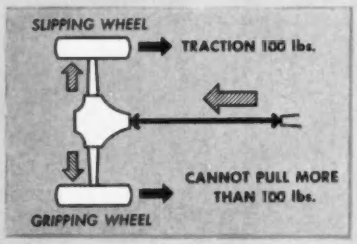


Power Flow with Poor Traction

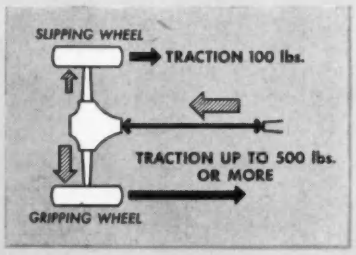
When traction conditions under the rear wheels are dissimilar, the driving force with an ordinary differential is limited by the wheel with the *poorer* traction. The POWR-LOK Differential enables the wheel with the *better* traction to apply the major driving force to the road. In this way the POWR-LOK equipped vehicle can operate in snow, ice, and mud which might stop a conventionally equipped unit.

With the Thornton POWR-LOK the wheel on the pavement continues to drive the car, and the wheel on the shoulder *does not spin*. In this way complete vehicle control is maintained and there is no dangerous swerve.

Comparative actions in starting a vehicle in snow, ice, mud, sand, etc.



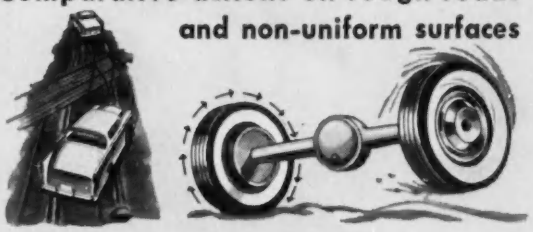
Snow at the curb presents a typical problem encountered by all types of vehicles in the winter months. This condition often offers traction on one wheel and no traction at the curb driving wheel. With the ordinary differential the curb wheel spins in the snow and the vehicle is stuck, as driving power to both wheels is equal and limited by the poor traction of the slipping wheel.



Under the same conditions the Thornton POWR-LOK differential applies many times the driving force of the curb wheel to the wheel on the street with the better traction, and the vehicle starts normally.

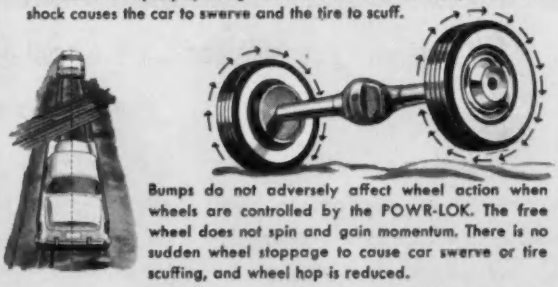
Similarly, the Thornton POWR-LOK's characteristic of applying the major driving force to the wheel with the better traction enables the vehicle to be operated in mud, sand, snow and on ice which would stall a unit with an ordinary differential.

Comparative actions on rough roads and non-uniform surfaces



When a rear wheel is thrown into the air by a bump or obstruction and road contact is broken, the ordinary differential spins the wheel which rapidly gains momentum.

When this rapidly-spinning wheel hits the road surface, the sudden shock causes the car to swerve and the tire to scuff.



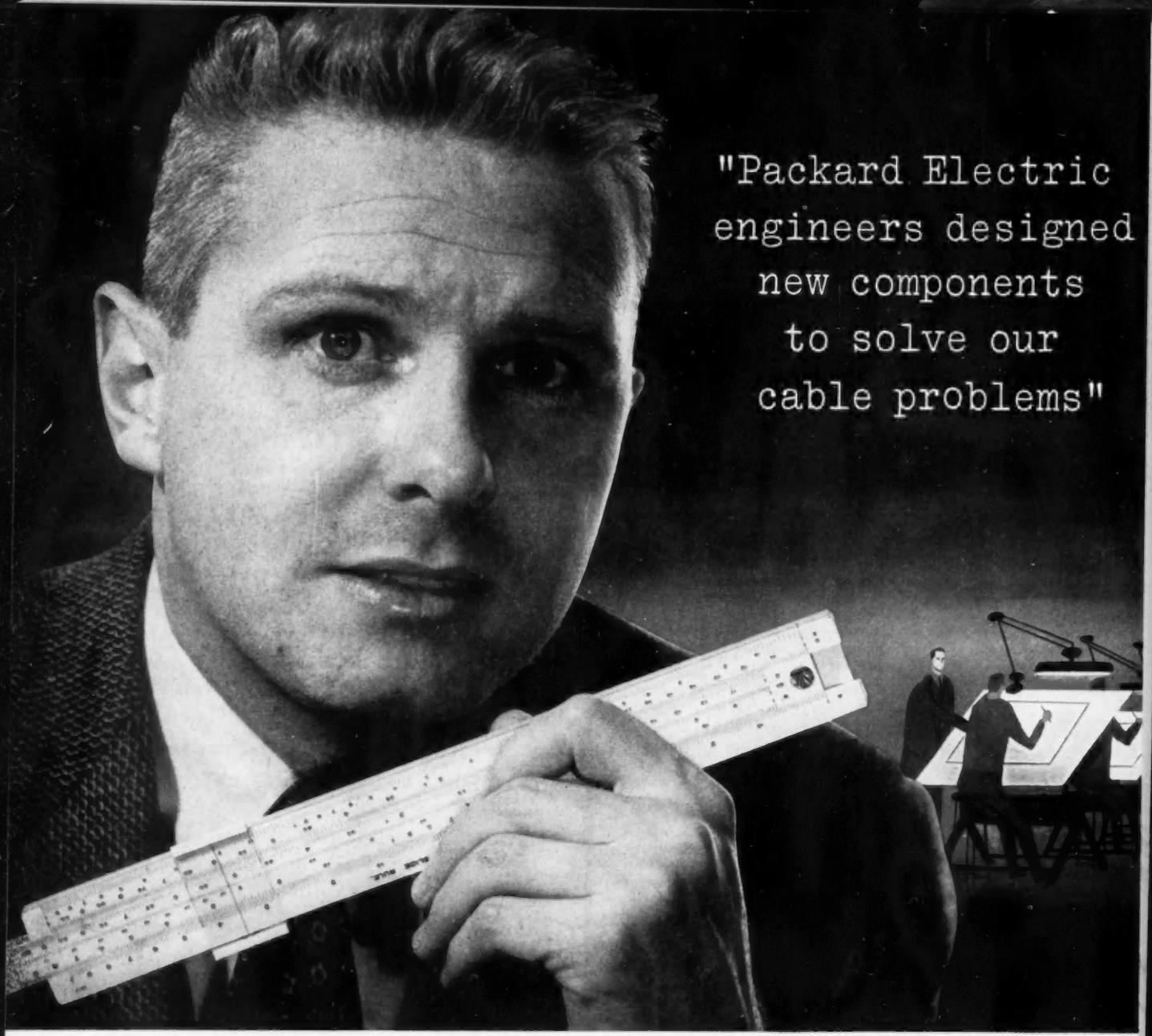
Bumps do not adversely affect wheel action when wheels are controlled by the POWR-LOK. The free wheel does not spin and gain momentum. There is no sudden wheel stoppage to cause car swerve or tire scuffing, and wheel hop is reduced.

These characteristics of the Thornton POWR-LOK differential contribute substantially to highway safety through improved high speed stability and handling of the vehicle.

Write for brochure illustrating and describing the efficiency and safety aspects of the new Spicer Thornton POWR-LOK Differential.

SPICER PRODUCTS: TRANSMISSIONS • UNIVERSAL JOINTS • PROPELLER SHAFTS • AXLES • TORQUE CONVERTERS • GEAR BOXES • POWER TAKE-OFFS • POWER TAKE-OFF JOINTS • RAIL CAR DRIVES • RAILWAY GENERATOR DRIVES • STAMPINGS • SPICER and AUBURN CLUTCHES • PARISH FRAMES • SPICER FRAMES

Spicer



Sound engineering consultation—and a good product—have made Packard Cable first in sales.

Can our engineers help you?

TO LESSEN IGNITION INTERFERENCE on radio, TV and other communication devices, Packard Electric developed a new, high-tension cable built with non-metallic conductor. This new cable suppresses electrical oscillations throughout the length of the circuit instead of only at one point as was previously possible.

FOR CABLE SUBJECTED TO ABRASION, weathering and other deteriorating elements, Packard Electric developed a new type plastic exterior insulation which not only *works* better but *looks* better on truck, tractor, boat and other engines.

PACKARD ENGINEERING WORKS FOR YOU in many ways. Whether you need a new cable component or a complex wiring harness, ready for snap-in installation—it will pay you to discuss the problem with us. Because we know the business *from the inside out* . . . more Packard Electric cable is used as original automotive equipment than all other makes combined.

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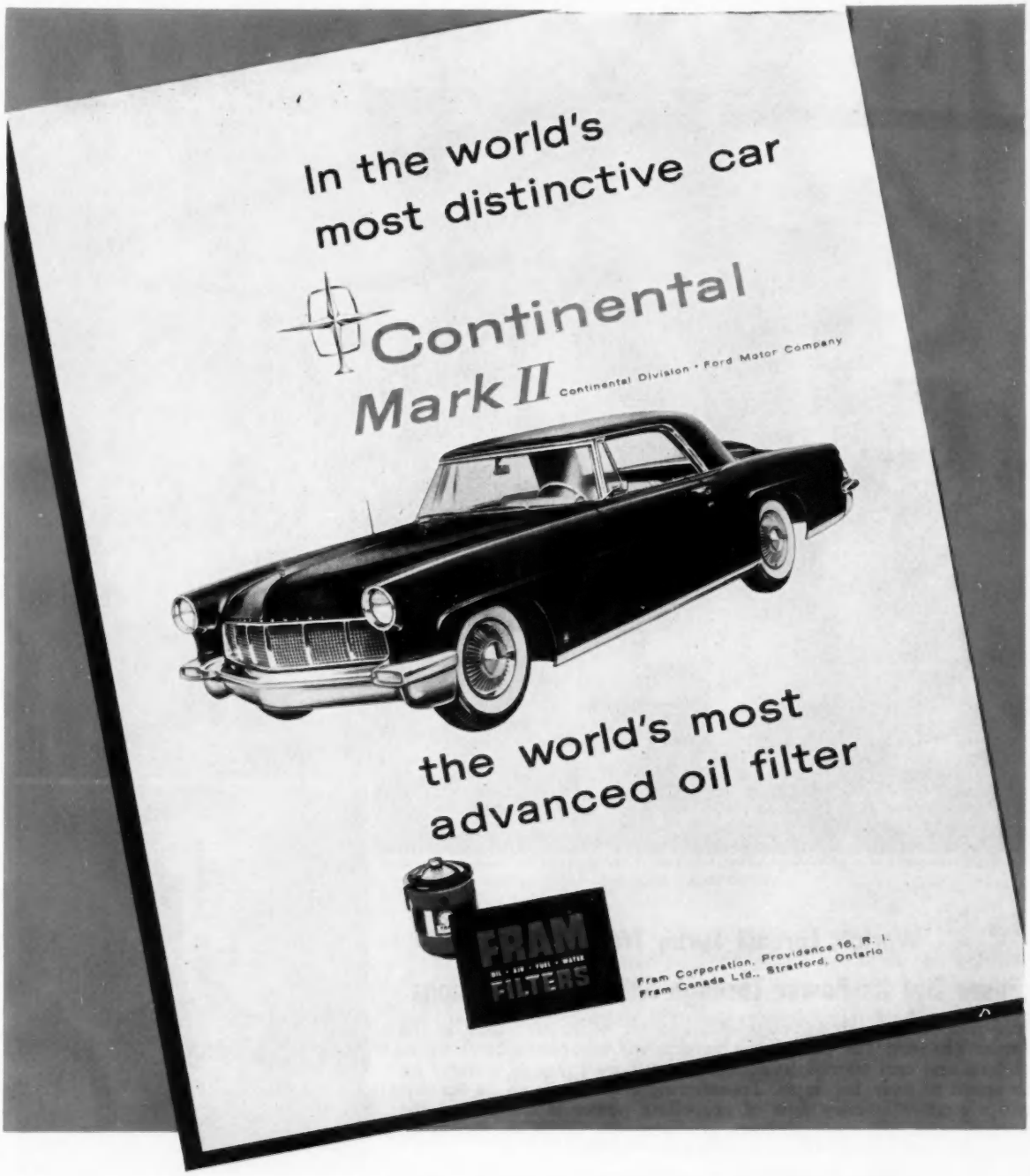

This distinguished advertisement* is still another reason why more and more motorists ask for FRAM Filters!

* *As published in* THE SATURDAY EVENING POST.

Selection of FRAM Filters by the Continental Division of Ford Motor Company for its fabulous Continental Mark II is just another milestone in the growing preference for FRAM.

Today more manufacturers, more dealers and more motorists prefer FRAM than any other oil filter made.

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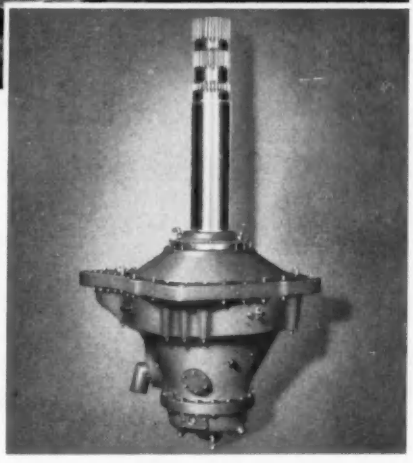
Fram Canada Ltd., Stratford, Ontario.

Expediting development of an inaccessible area with helicopter . . . in transporting men, machinery, material.

World's Largest Turbo Transporter Pours Out Its Power Through SPECO Transmissions

This mammoth turbine-powered helicopter of "1001" uses is the Vertol YH-16A. The production version will be able to carry up to 12 tons and can whirl into action without warm-up to achieve an air speed of over 150 mph. Transferring the output of its turbine into a smooth, steady flow of propelling power is the job of the forward and aft transmissions produced by SPECO, the Steel Products Engineering Division of Kelsey-Hayes.

The manufacture and assembly of gears and gear assemblies which insure dependable, maintenance-free performance such as required in the Vertol YH-16A is a Speco specialty, one of 40 years standing in service to the aviation industry.

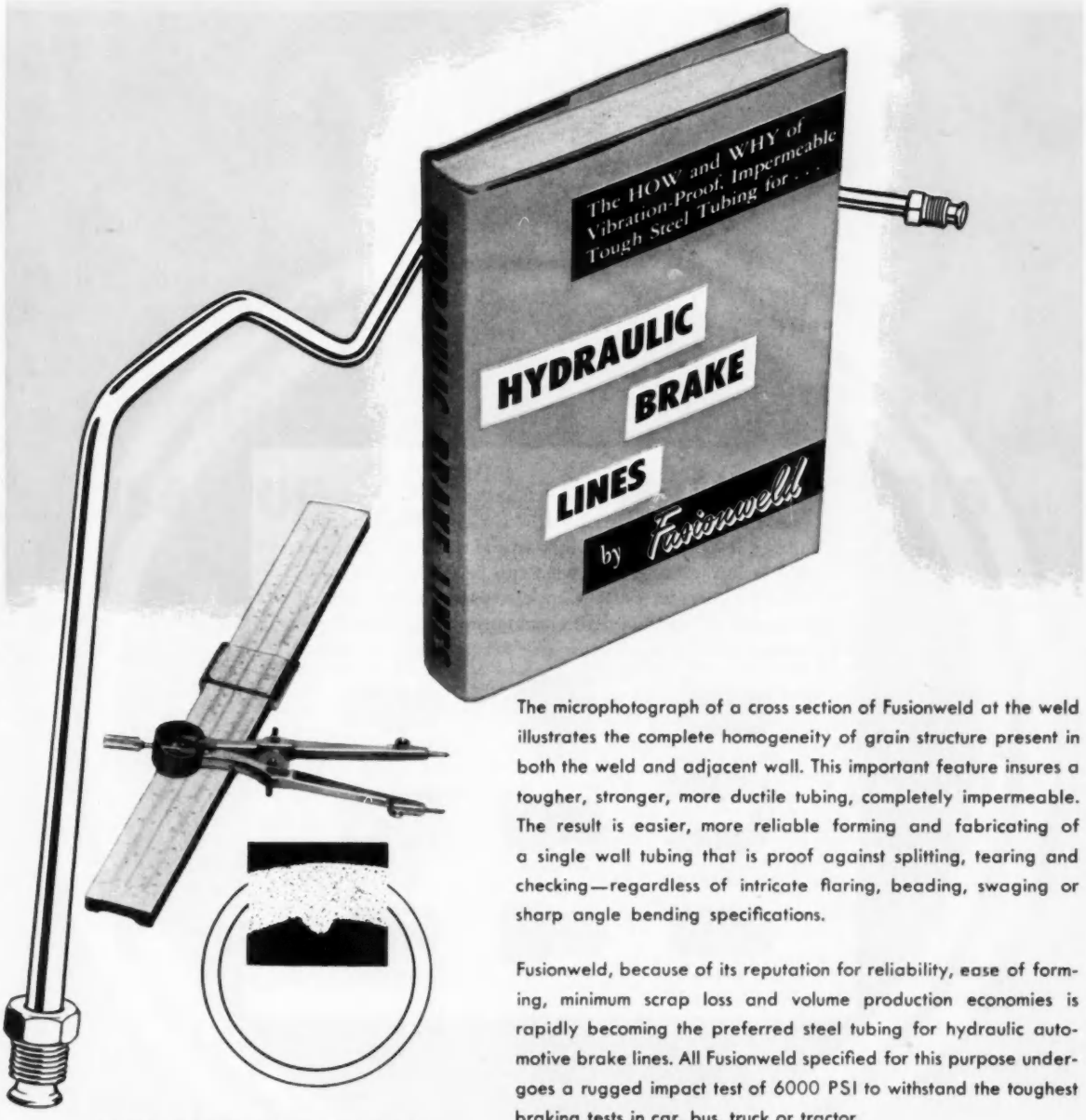


Rotor transmission from YH-16. The transmissions, clutch assemblies, synchronizing shafts and drive shaftings are produced by Kelsey-Hayes in accordance with Vertol's design specifications.

KELSEY-HAYES

Kelsey-Hayes Wheel Co., Detroit 32, Mich. • Major Supplier to the Automotive, Aviation and Agricultural Industries

TEN PLANTS / Detroit and Jackson, Michigan; McKeesport, Pa.; Los Angeles, Calif.; Windsor, Ontario, Canada • Davenport, Iowa (French & Hecht Farm Implement and Wheel Division) • Springfield, Ohio (SPECO Aviation, Electronics and Machine Tool Division)



The microphotograph of a cross section of Fusionweld at the weld illustrates the complete homogeneity of grain structure present in both the weld and adjacent wall. This important feature insures a tougher, stronger, more ductile tubing, completely impermeable. The result is easier, more reliable forming and fabricating of a single wall tubing that is proof against splitting, tearing and checking—regardless of intricate flaring, beading, swaging or sharp angle bending specifications.

Fusionweld, because of its reputation for reliability, ease of forming, minimum scrap loss and volume production economies is rapidly becoming the preferred steel tubing for hydraulic automotive brake lines. All Fusionweld specified for this purpose undergoes a rugged impact test of 6000 PSI to withstand the toughest braking tests in car, bus, truck or tractor.

HERE'S PART OF THE STORY

Fusionweld thin-wall steel tubing is produced by a special technique developed in our mills by a hi-cycle type of resistance welding. The tubing is then annealed in specially designed furnaces and cold drawn by a unique die sinking process which provides a perfectly smooth O.D., imparts a high degree of tensile strength and toughness, making it especially resistant to vibration and fatigue—hence ideal for automotive applications.

√ √ √ *NOW GET THE PROOF* √ √ √

Let us tell you the complete story on Fusionweld for brake lines . . . its amazing performance records and cost cutting advantages. Today millions of feet monthly are employed by motor car manufacturers.

Our current catalog will be mailed on request.

AVON TUBE DIVISION
HIGBIE MANUFACTURING CO.
ROCHESTER • MICHIGAN

End section of Bundyweld Tubing shows exclusive double-walled, single-strip construction (details below). Tubing is uniformly smooth, inside and out, with no bead at lap joints. Bundyweld can be fabricated easily, bends to shortest radii. Copper-coated on all exposed surfaces, facilitating coating, soldering, or brazing operations. Inset shows but a few fabrication processes.

BUNDYWELD IS DOUBLE-WALLED FROM A SINGLE STRIP

Bundyweld starts as a single strip of copper-coated steel. Then it's . . .

continuously rolled twice around laterally into a tube of uniform thickness, and

passed through a furnace. Copper coating fuses with steel. Result . . .

Bundyweld, double-walled and brazed through 360° of wall contact.

← **NOTE** the exclusive Bundy-developed beveled edges, which afford a smoother joint, absence of bead, and less chance for any leakage.

Here's the reason why Bundyweld Steel Tubing is used on 95% of today's cars

Only steel tubing can take the punishment; and only Bundyweld is double-walled from a single steel strip for absolute dependability.

Look closely at the unique construction of Bundyweld Steel Tubing, and you will see the reason why it is specified by automobile manufacturers for safety and dependability.

Because of its strength, durability, and ease of fabrication, Bundyweld is universally used by the industry in brake lines, fuel lines, oil lines, and dozens of other vital automotive uses. It is found *in 95% of today's cars, in an average of 20 applications each.* Only *steel* tubing can stand up under the punishment; Bundyweld is tough, rugged, takes the wear and tear in stride.

Your product, too, may need these outstanding Bundyweld properties: leakproof by test; thinner-walled yet stronger; high thermal conductivity; easily fabricated; takes easily to standard protective coatings.

Backed by unexcelled engineering and fabrication facilities, Bundy offers a wealth of special services to its customers. Technicians are available, at your request, to help at any stage of your product development where the right answer to a tubing question is vital.

For information, write, wire, or call us today!

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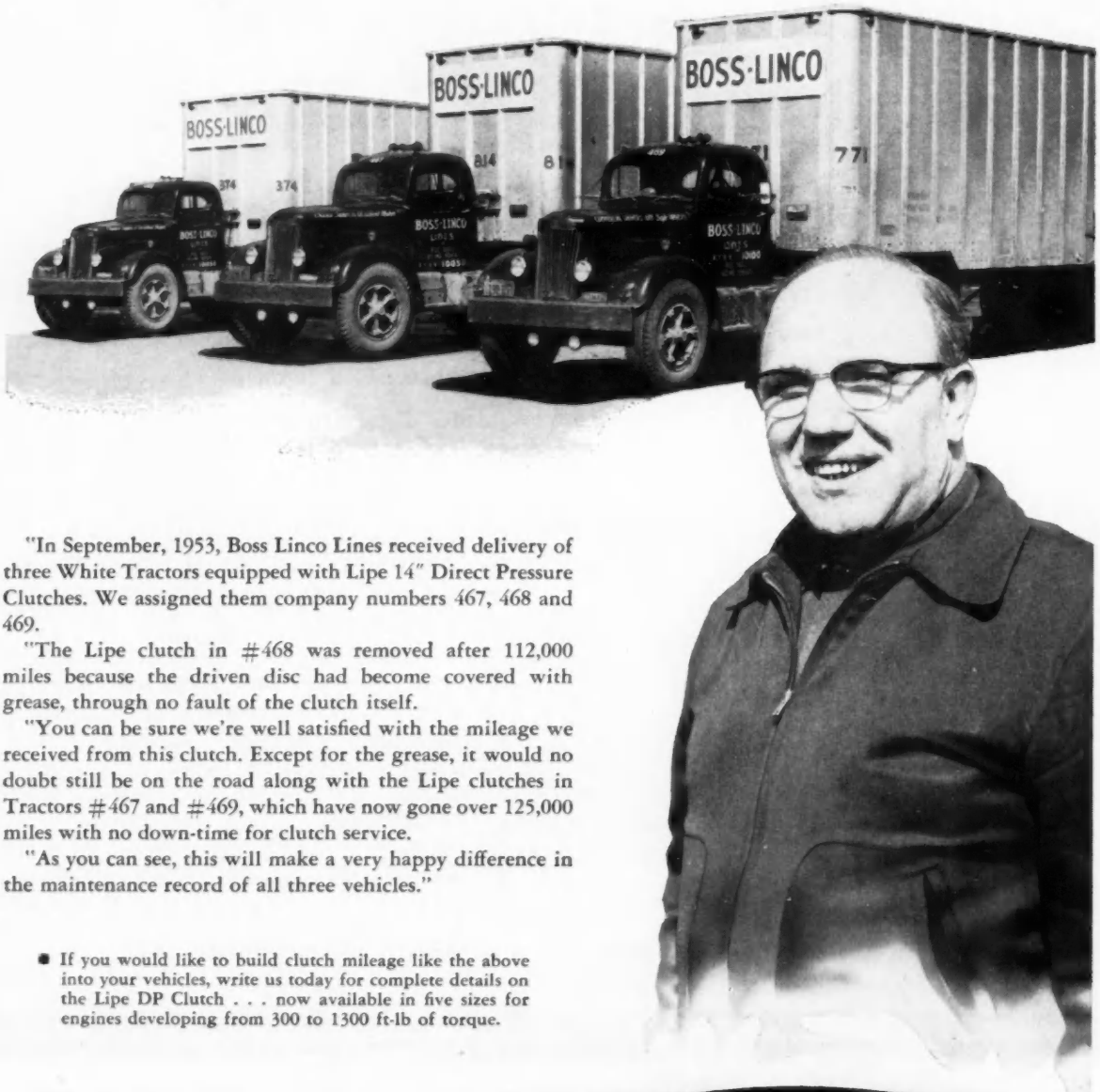
"One Lipe DP Clutch went 112,000 miles without teardown . . . two more are past 125,000 and still going strong."

— *says* **CHRIS CASCIA, Maintenance Superintendent**
Boss Linco Truck Lines, Buffalo, N. Y.



"In September, 1953, Boss Linco Lines received delivery of three White Tractors equipped with Lipe 14" Direct Pressure Clutches. We assigned them company numbers 467, 468 and 469.

"The Lipe clutch in #468 was removed after 112,000 miles because the driven disc had become covered with grease, through no fault of the clutch itself.

"You can be sure we're well satisfied with the mileage we received from this clutch. Except for the grease, it would no doubt still be on the road along with the Lipe clutches in Tractors #467 and #469, which have now gone over 125,000 miles with no down-time for clutch service.

"As you can see, this will make a very happy difference in the maintenance record of all three vehicles."

- If you would like to build clutch mileage like the above into your vehicles, write us today for complete details on the Lipe DP Clutch . . . now available in five sizes for engines developing from 300 to 1300 ft-lb of torque.

Manufacturers of Automotive Clutches & Machine Tools

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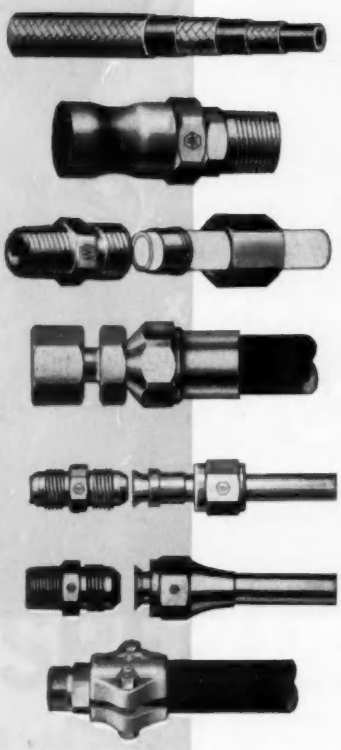
. . . First in Components for Hydraulic Systems



5 TYPES OF INDUSTRIAL HOSE for low, medium, medium-high and high pressure applications; available in complete size ranges; suited for any service condition.

REUSABLE HOSE ENDS for fast assembly and positive, leakproof connections. Rugged construction that cuts costs through repeated use. Designed to insure maximum flow. Only Weatherhead gives you fittings with extra-long gripping area for dependable performance under high pressures.

ERMETO® fittings in steel and stainless steel for leakproof seals without flaring, threading or welding. Withstand shock loads, vibration and impulse at highest pressures. Ermeto connections can be uncoupled and reassembled time after time.

ERMETO REUSABLE HOSE ENDS for connecting hose assemblies directly to block; available from stock in standard sizes. Specified by major diesel manufacturers for high pressure fuel injection lines.

37° FLARED STEEL FITTINGS conform fully to J. I. C. standards. Available in all types and sizes with tube or dry seal pipe thread outlet.

BRASS FITTINGS S.A.E. 45° flare, compression, inverted flare, double compression (threaded sleeve), are machined from extruded stock, giving strength equal to forgings. Large, flat wrench pads provide easy gripping for fast assembly, even in hard-to-reach places.

CLAMP-TYPE REUSABLE HOSE ENDS for all two-wire braid high pressure hydraulic hose applications. No skiving of hose or special tools required. Cadmium-plated, malleable cast iron ends available in sizes ¼″, ⅜″, ½″, ¾″, 1″, 1¼″, 1½″ and 2″.

WEATHERHEAD FIELD ENGINEERS are readily available to help you gain the advantages of this complete, dependable line..... Weatherhead Catalogs provide complete data on products and applications. Write: The Weatherhead Company, Dept. AD5, 128 West Washington Blvd., Fort Wayne, Indiana.

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THE ONLY SINGLE-SOURCE
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Available coast-to-coast through
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FIRST IN HYDRAULIC CONNECTIONS
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Dept. AD-5, 128 West Washington Blvd., Fort Wayne, Indiana
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ROHR-BUILT POW-R-PAX *on the wing* OF THE BOEING KC-135 STRATOTANKER

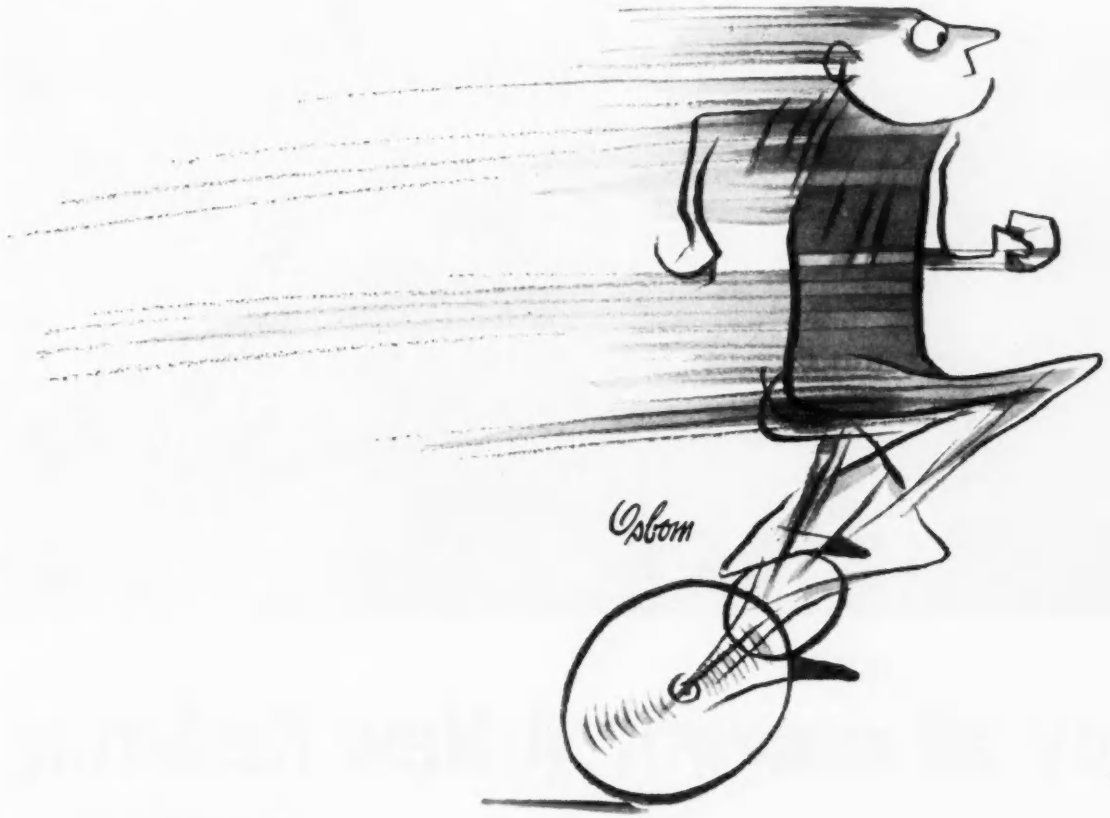
Rohr is the world's leading builder of ready-to-install Pow-R-Pax for airplanes like the Boeing KC-135, Douglas DC-7, Lockheed Super Constellation, Convair 440, and fifteen other great military and commercial planes.

Next time call on the Rohr design, engineering and production know-how gained from building thousands of Pow-R-Pax and over 30,000 other different parts for aircraft of all kinds.

WORLD'S LARGEST PRODUCER OF READY-TO-INSTALL POW-R-PAX FOR AIRPLANES

ROHR
AIRCRAFT CORPORATION

Chula Vista and Riverside, California



SPEED

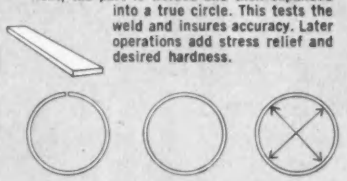
and heavier payloads are putting increased demands on today's truck and trailer rims. To meet these higher standards, more and more manufacturers specify Cleve-Weld Protecto-tire rims.

6-point "safety-age" design makes Cleve-Weld rims top performers

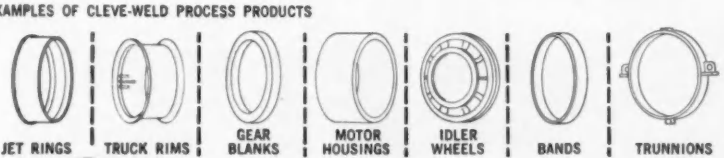
1. Rim thickened at strategic points... increases resistance to severe stress.
2. Tapered beads on both sides of rim ...tire mates firmly with the rim.
3. 28° mounting bevel... enables rim to be mounted on *all* cast wheels.
4. Lightweight construction... means higher payloads for customers without loss of strength.
5. Tire rests on tapered bead seat...tire stays put when puncture occurs.
6. Designed for any brand or type of tire... flexibility ends tire replacement problems.

For 45 years, Cleve-Weld has been a specialist in the manufacture of rolled and welded circular products. There are real dollars-and-cents reasons why *it will pay you to specify Cleve-Weld as your primary source for all rolled and welded circular parts.* We'd like to talk it over. Write address below.

THIS IS THE BASIC CLEVE-WELD PROCESS. Rectangular bars or special contoured sections of steel are rolled into a circular form. Next, the part is welded and then expanded into a true circle. This tests the weld and insures accuracy. Later operations add stress relief and desired hardness.



EXAMPLES OF CLEVE-WELD PROCESS PRODUCTS



Another AMF Product

CLEVE-WELD PROCESS
RIMS · RINGS · WELDMENTS

CLEVELAND WELDING DIVISION
AMERICAN MACHINE & FOUNDRY COMPANY
Cleveland 7, Ohio

SEND THIS COUPON NOW

Cleveland Welding Division
American Machine & Foundry Company
West 117th Street and Berea Road
Cleveland 7, Ohio

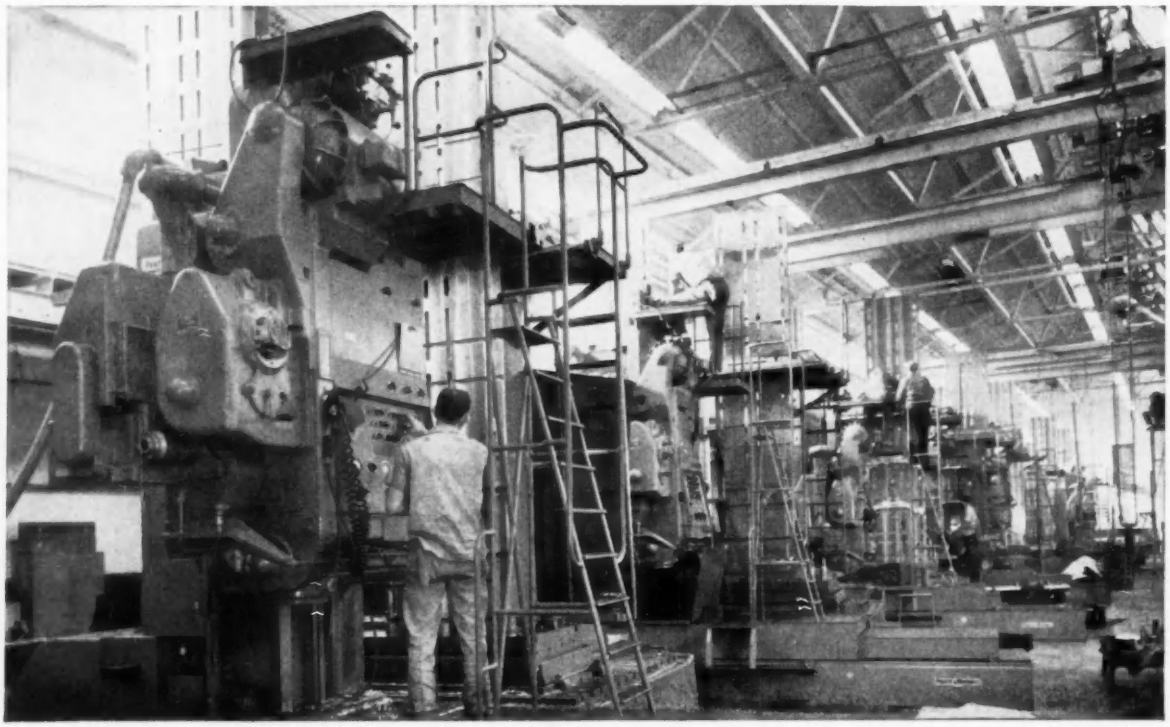
Please send me:

- ☐ Truck Rim Catalog
- ☐ Tractor Rim Catalog
- ☐ Brochure on Cleve-Weld Process

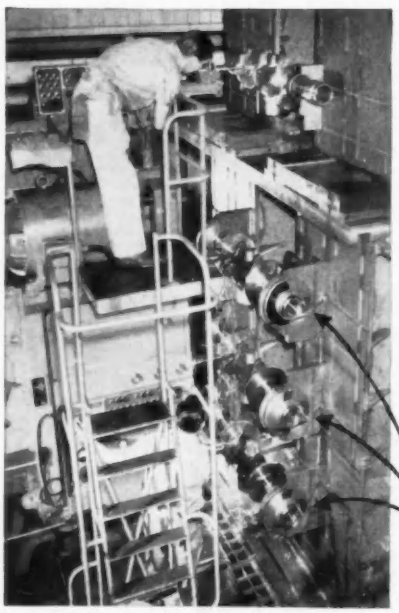
Name_____

Title_____

Attach to your company letterhead and mail



at CPT ... A New Kellering



From the pattern at top, three aircraft landing gear axles are Kellered at one time. Axles being machined are indicated by asterisk.

● At CPT, we've installed eight BG-22, 3-spindle Pratt & Whitney Kellering machines. These 8 Kellers added to our single-spindle and two-spindle Kellers give us a total of 10 machines.

Each of the 3-spindle Kellers can produce three identical complex parts from a master ... at the same time. Per-price cost is reduced, delivery is speeded, uniformity of contour and surface is assured. Even the most intricate and convoluted surfaces are accurately machined by tools that duplicate the contours of the master pattern.

In addition to the services of our battery of Kellers, CPT offers you the services of a complete collection of modern machine tools of all types: lathes, gap lathes, turret lathes, end mills, milling machines, grinders, hobbing machines, and thread grinders.

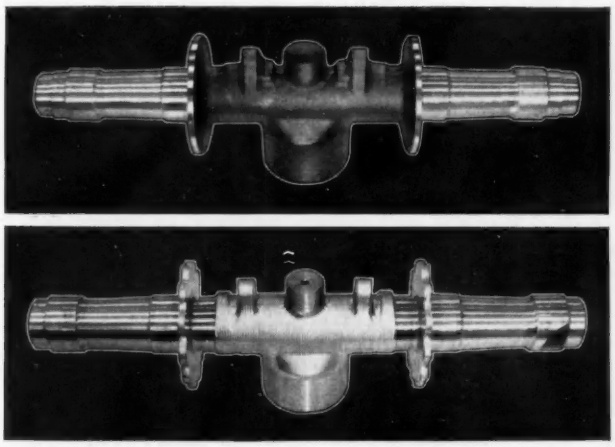
CPT

CLEVELAND PNEUMATIC

TOOL COMPANY • Dept. K-556 • Cleveland 5, Ohio

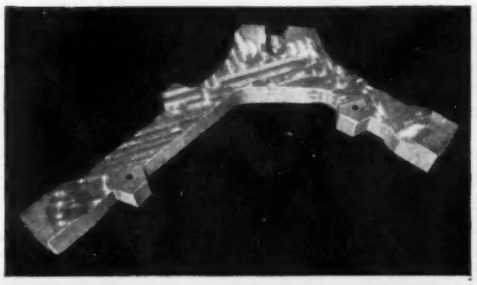
Sales-engineering offices in Seattle, Los Angeles, Fort Worth-Dallas, and Levittown, L. I.

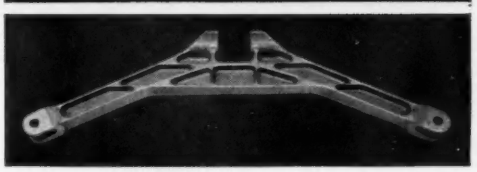
CPT ... world's largest and most experienced builder of landing gears and ball-screw mechanisms



General view of the Kellering Department at CPT, showing the 8 new 3-spindle Kellers.

Top photo shows an aircraft axle before it was Kellered. Bottom photo shows it after Kellering.





This aircraft structural part has been Kellered from a forging similar to the one shown at top.

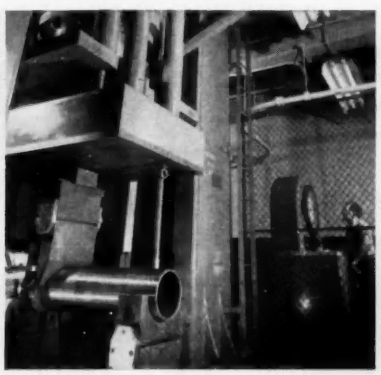
Division is ready to work for you

The world's largest flash-butt welding machine is also a part of CPT's facilities. Hollow steel sections up to 100 square inches in weld-face area are joined automatically and almost instantaneously.

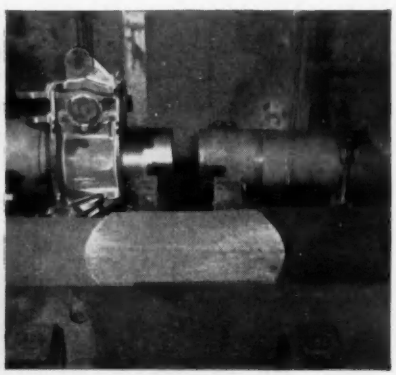
Other facilities include batteries of heat-treating furnaces, magnaflux and zyglo inspection equipment and a Baldwin-Southwark testing machine with 1,000,000 lbs. capacity in tension or compression.

Before you invest in high-cost facilities and machines for your plant, investigate CPT's new Kellering Division's facilities that are supplemented by one of the most complete aircraft-quality production plants in the country. CPT also offers complete design and production engineering services.

Part of the battery of electric heat-treating furnaces at CPT. Pieces up to 13 feet long can be handled in these furnaces and quench tanks.



CPT's Baldwin-Southwark one-million-pound-capacity tensile testing machine can exert this pressure either in tension or compression.



Kellered head section about to be joined to cylinder tube by resistance welding on CPT's giant flash-butt welder.

WANTED! ENGINEERS TO HELP MAKE LONG RANGE MISSILE HISTORY

North American's Missile Projects Offer A New Engineering Adventure

With complete weapons system responsibility for the SM-64 NAVAHO Intercontinental Guided Missile, North American is engaged in one of the most challenging programs yet offered. But every inch of progress is a tough scientific battle. New means are daily being found to solve the complex problems which the development of long range missiles presents in the fields of structures, temperatures and aerodynamics. But most important of all, *men* must be found who thrive on this kind of challenge . . . men who are really excited about this new missile science. Are you one of them?

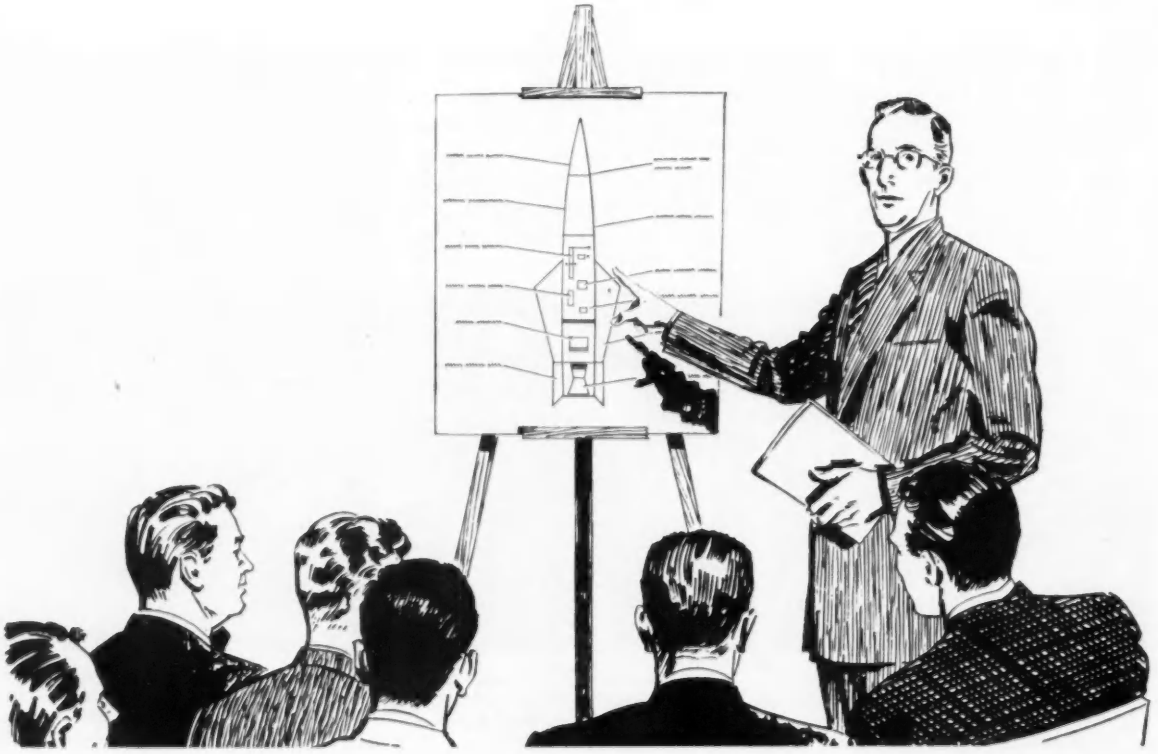
If you qualify in one of the fields we have listed below, chances are you can qualify for this unique expedition into the technology of the future. We would like to tell you about all the physical and professional advantages of a career in North American's Missile Development Engineering.

Please contact us for the full story:

Instrumentation Design, Development & Application **Standards, Drawings Checking, Specifications Writing**
Structures, Stress, Flutter and Aeroelasticity **Component and System Reliability Engineering** **Thermodynamics**
Missile Airframe Design **Hydraulic, Pneumatic & Servo Engineering** **Armament Systems & Components Engineering**
Aerodynamics **Engineering Flight Test** **High Temperature Materials Engineering** **Mechanical & Electrical Design**

Contact: R. L. Cunningham, Missile Engineering Personnel Office
Dept. 91-20 SAE, 12214 Lakewood Boulevard, Downey, Calif.
Phone: LOgan 5-8651 Ext. 518
Interviews 8 A.M. to 9 P.M. Monday through Friday

NORTH AMERICAN AVIATION, INC.



Now Warranted FOR 100,000 MILES

---or 1 year
---or 4,000 hours

Simple as ABC

— only three essential parts

A—Inertia mass or flywheel

B—High viscosity synthetic fluid

C—Sealed two-piece housing

— minimizes both major and minor critical orders of vibration

Patented in U.S.A. and foreign countries

The performance and dependability of the fully patented Houdaille Viscous Torsional Vibration Damper is well known to more than 25 makers of gasoline and diesel engines.

Since its introduction 10 years ago, it has been smoothing the performance and protecting the life of *millions* of engines.

Houdaille now backs this record with a 1-year, 100,000-mile, 4,000-hour Warranty (whichever occurs first) against defects in workmanship and material . . . the *first* of its kind in the industry.

Houdaille engineers will be glad to design a Viscous Torsional Vibration Damper to meet the individual characteristics of your engine, large or small.

HOUDAILLE INDUSTRIES, Inc.*

BUFFALO HYDRAULICS DIVISION | 537 East Delavan Avenue, Buffalo 11, N. Y.

**formerly Houdaille-Hershey Corporation*

ENGINEERS...

LOOK TEN YEARS AHEAD!

Will your income and location allow you to live in a home like this... spend your leisure time like this?

A Douglas engineer lives here

They can...if you start your career now at Douglas!

Take that ten year ahead look. There's a fine career opportunity in the engineering field you like best waiting for you at Douglas.

And what about the Douglas Aircraft Company? It's the biggest, most successful, most stable unit in one of the fastest growing industries in the world. It has giant military contracts involving some of the most exciting projects ever conceived . . . yet its commercial business is greater than that of any other aviation company.

The Douglas Company's size and variety mean that you'll be in the work you like best — side by side with the men who have engineered the finest aircraft and missiles on the American scene today. And you'll have every prospect that ten years from now you'll be where you want to be career-wise, money-wise and location-wise.

For further information about opportunities with Douglas in Santa Monica, El Segundo and Long Beach, California divisions and Tulsa, Oklahoma, write today to:

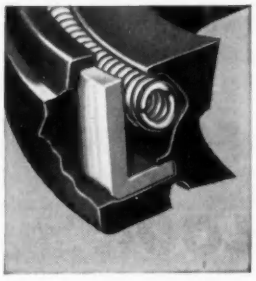
DOUGLAS AIRCRAFT COMPANY, INC.

C. C. LaVene, 3000 Ocean Park Blvd., Santa Monica, California

DOUGLAS

First in Aviation

Heavy-duty dual sealing at single seal cost



Type K4 with Victoprene on O.D.

For installations requiring sealing element on outer periphery and outside face, K4 seals are so designed. Otherwise, construction is identical with K6 seal as above.

The K6 offers you highly developed double lip design with integral metal O.D. case and supplementary edge sealing. Thoroughly proven on heavy-duty applications, this construction is the modern replacement for costlier compound element seals and multiple seal installations.

The K6's efficient dual function of sealing in lubricant and sealing out foreign matter permits maximum compactness in seal housing.

The sealing element is oil-, age- and heat-resisting Victoprene synthetic rubber. Exclusive Victor process of mechanical and chemical bonding combines the element and metal case into a permanent single-unit structure.

Other K6 Features

The supplementary Victoprene edge compresses against shoulder on base to assure positive O.D. seal with metal to metal O.D. press fit.

Valley between sealing lips retains initial lubricant for minimum friction and longer sealing life.

Unitary construction for minimum width requirements. Available in minimum width of ¼ inch, and for shaft diameters up to 7 inches.

Available with or without garter spring on primary sealing lip.

External or secondary sealing lip, molded with initial light interference, permits satisfactory installation. Upon installation, the primary sealing lip displaces to increase sealing efficiency of secondary member through flex action.

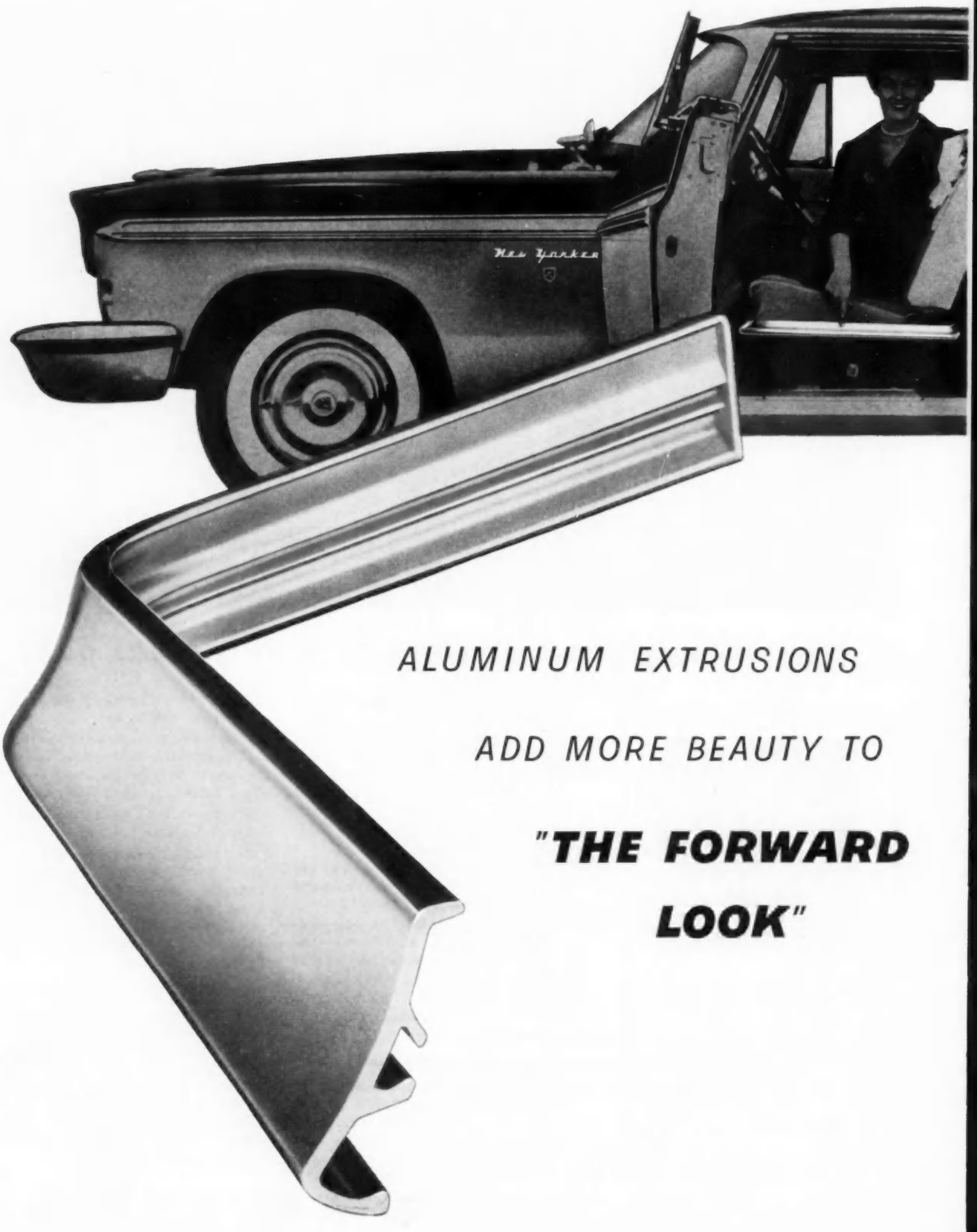
You Can Save with This Seal

The K6 assures finest dual sealing with single seal economy. Get complete specifications and recommendations through your Victor Field Engineer, or by writing: Victor Mfg. & Gasket Co., P.O. Box 1333, Chicago 90, Ill. *In Canada:* Victor Mfg. & Gasket Co. of Canada Ltd., St. Thomas, Ont.

VICTOR

Sealing Products Exclusively

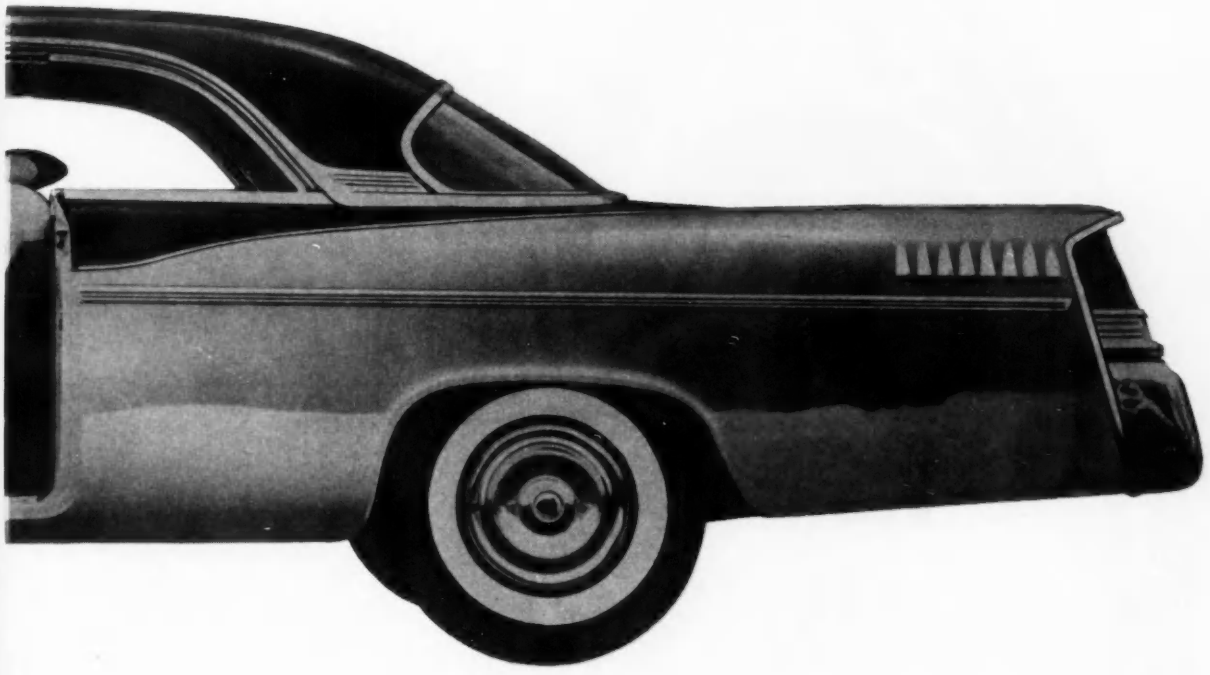
OIL SEALS • GASKETS • PACKINGS



ALUMINUM EXTRUSIONS

ADD MORE BEAUTY TO

"THE FORWARD LOOK"



Chrysler Corp. engineers and stylists, always on the alert for new ways to improve design and reduce cost, recently changed seat moulding specifications on the Chrysler New Yorker and Imperial.

The new parts are beautiful, massive-appearing aluminum extrusions. Light Metals Co. of Grand Rapids is the supplier, using materials furnished by Kaiser Aluminum.

Aluminum extrusions were chosen over all other materials because of their beauty and economy.

BEAUTIFUL PARTS MADE POSSIBLE

Chrysler engineers found that the aluminum extrusion process made beautiful parts easy to produce. An extremely wide choice of graceful, decorative forms and shapes were made possible—and virtually any design created could be produced quickly and at lower cost than was possible with any other method.

Beautiful satin finishes were easily achieved by etching and anodizing . . . making aluminum's natural beauty extremely resistant to corrosion and abrasion.

TOOLING COSTS NEGLIGIBLE

Aluminum extrusions *drastically reduced tooling costs!* Simple tooling, limited to the die and standard bending jigs, also made it possible to quickly establish multiple sources of supply.

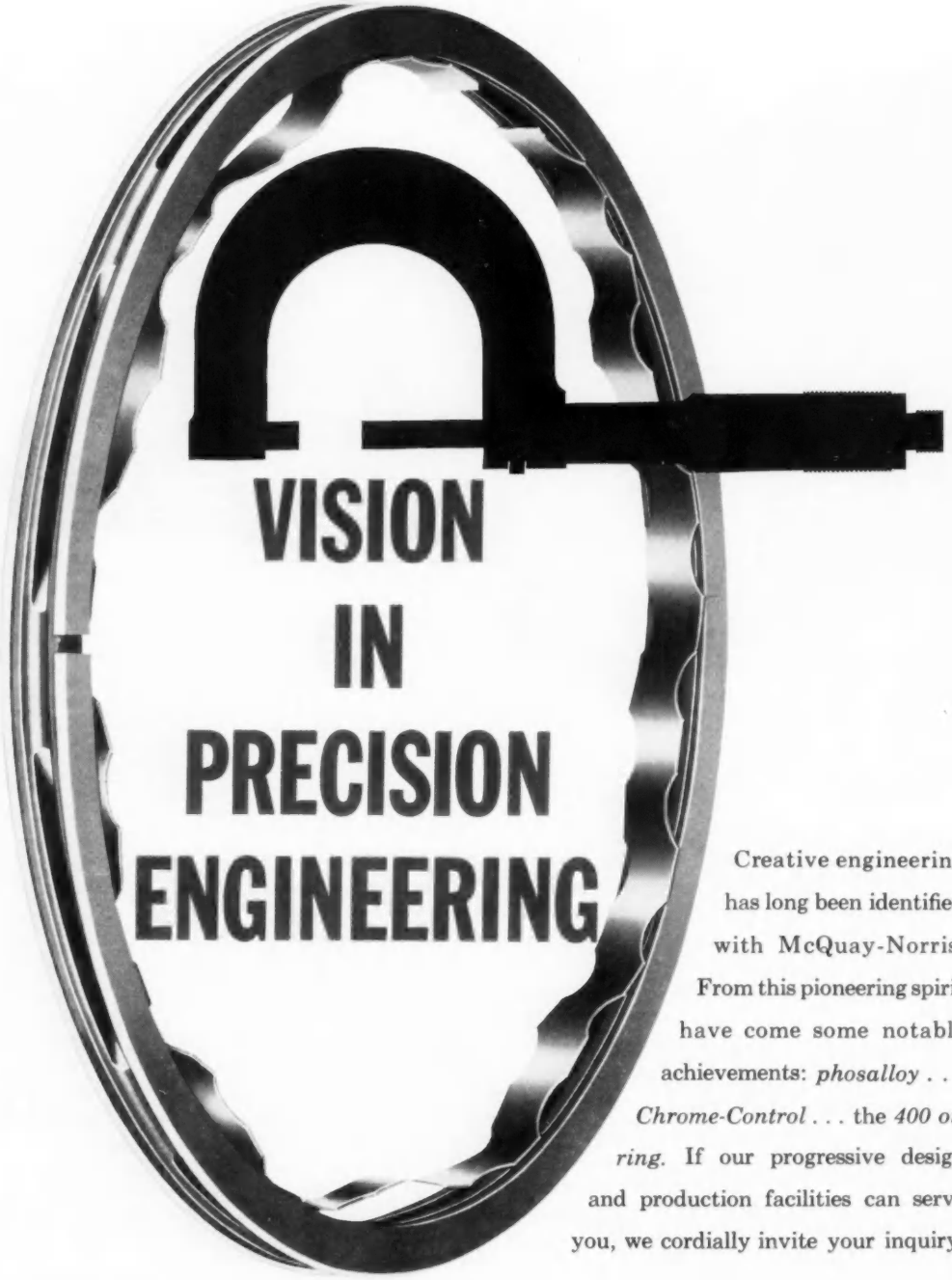
Versatile aluminum is helping to improve automotive design and reduce cost in many ways. Improvements and substantial savings are being made in screw machine parts and structural and functional components, as well as in trim and molding sections.

We are eager to work with you as an "idea partner." Let our automotive development engineers examine the parts now being used in your production so that we may recommend improvements and savings you can effect by specifying aluminum.

★ ★ ★

For immediate service, call TRinity 3-8000, Kaiser Aluminum & Chemical Sales, Inc., 1414 Fisher Bldg., Detroit, Michigan; *General Sales Office,* Palmolive Bldg., Chicago 11, Ill.; *Executive Office,* Kaiser Bldg., Oakland 12, Calif.

Kaiser Aluminum



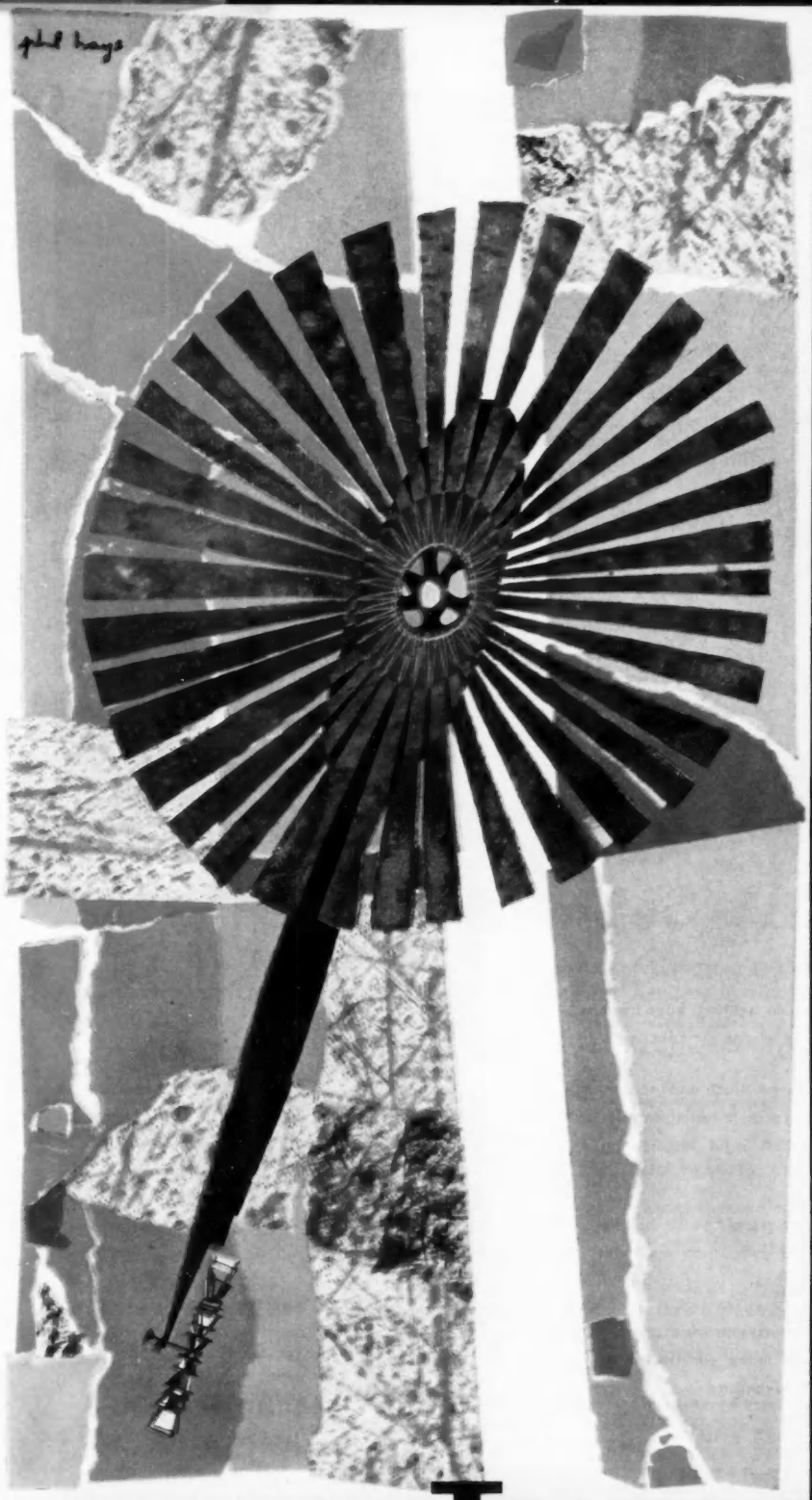
VISION IN PRECISION ENGINEERING

Creative engineering has long been identified with McQuay-Norris. From this pioneering spirit have come some notable achievements: *phosalloy* . . . *Chrome-Control* . . . the *400 oil ring.* If our progressive design and production facilities can serve you, we cordially invite your inquiry.

McQUAY-NORRIS

PISTON RINGS . . . HARDENED AND GROUND PARTS

McQUAY-NORRIS MANUFACTURING COMPANY
ST. LOUIS—TORONTO



Avco Lycoming lifts America into a new era of flight

A few tomorrows from now, giant whirlybirds will whisk you aloft, speed you hundreds of miles away, and deliver you—minutes later—*a few steps from your destination.*

To give America this new get-up-and-go, Avco's Lycoming division is readying sure, dependable power in unprecedented volume. Today, engines built by Lycoming drive more 'copters than any other engines in the world. And Lycoming scientists, who recently created the first gas turbine for 'copters (the 825-hp. T-53 for the Army's new utility Bell XH-40), continually explore new *sources* of 'copter power.

Helicopter travel—like private business flight—is one of the great American possibilities being hastened toward practical reality by the surging power of Lycoming.

For booklet, "Helicopter Power Plants," or for help on any problem involving power—wire, phone or write to Avco Defense and Industrial Products, Stratford, Conn.

ENGINEERS WANTED: Rewarding careers for outstanding men. Write to Vice President, Industrial Relations, Stratford, Conn.

FOR A COPY OF THIS PHILLIP HARRISON HAYS ILLUSTRATION, SUITABLE FOR FRAMING, WRITE TO PUBLIC RELATIONS DEPT., AVCO DEFENSE AND INDUSTRIAL PRODUCTS, STRATFORD, CONN.

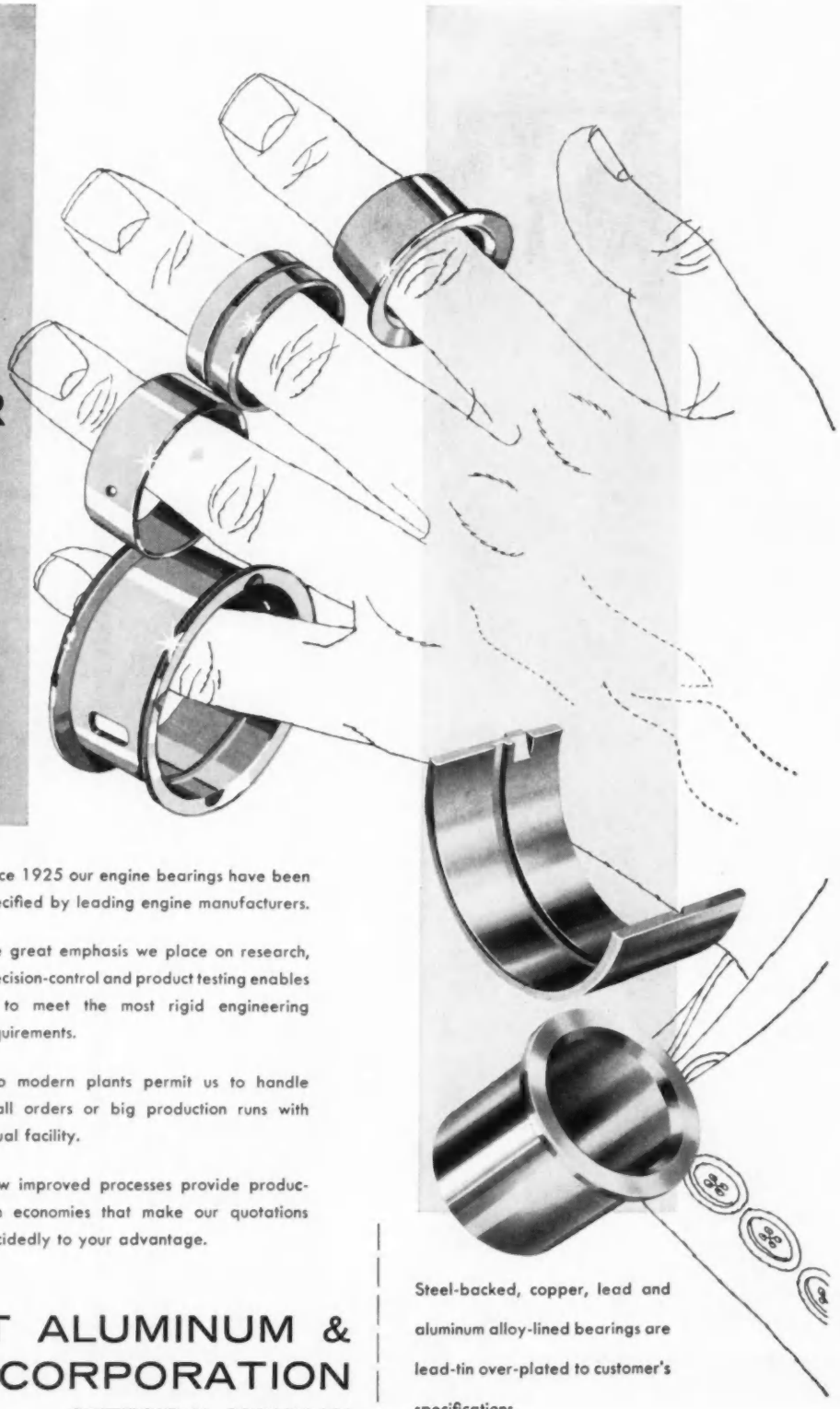
avco Lycoming

Avco Defense and Industrial Products combine the scientific and engineering skills, and production facilities of three great divisions of Avco Manufacturing Corp.: Lycoming; Advanced Development; Crosley—to produce power plants, electronics, airframe components, and precision parts.

defense and industrial products

TODAY'S MILITARY SERVICES, WITH THEIR TREMENDOUS TECHNOLOGICAL ADVANCES MADE POSSIBLE THROUGH SCIENCE, OFFER A VITAL REWARDING CAREER

4 THINGS TO REMEMBER THE NEXT TIME YOU BUY ENGINE BEARINGS



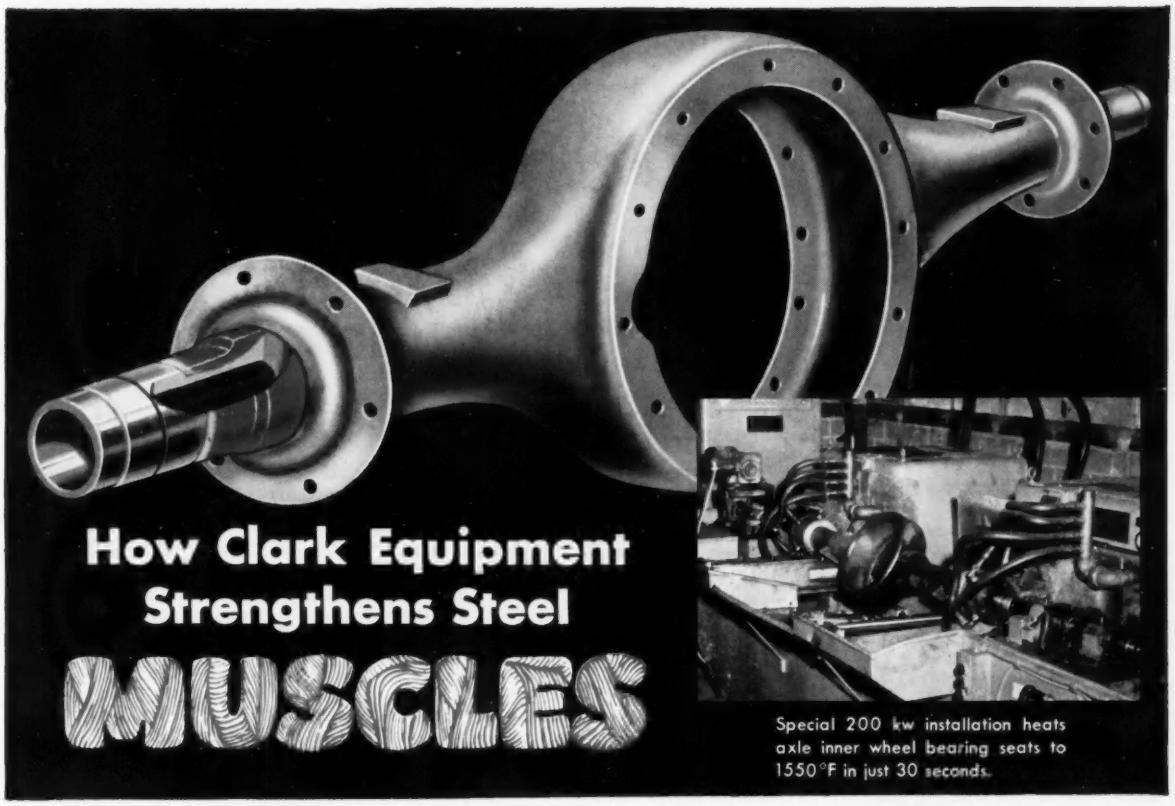
1. Since 1925 our engine bearings have been specified by leading engine manufacturers.
2. The great emphasis we place on research, precision-control and product testing enables us to meet the most rigid engineering requirements.
3. Two modern plants permit us to handle small orders or big production runs with equal facility.
4. New improved processes provide production economies that make our quotations decidedly to your advantage.

Steel-backed, copper, lead and aluminum alloy-lined bearings are lead-tin over-plated to customer's specifications.

DETROIT ALUMINUM & BRASS CORPORATION

DETROIT 11, MICHIGAN

Plants at Detroit, Michigan and Bellefontaine, Ohio


How Clark Equipment
Strengthens Steel
MUSCLES
Special 200 kw installation heats axle inner wheel bearing seats to 1550°F in just 30 seconds.

with TOCCO* Induction Heating

Progressive engineers at Clark Equipment Company's Axle Division recently adopted TOCCO Induction Heating for hardening the inner wheel bearing seats of their axle housings. TOCCO*-hardening is strictly a "quality specification"—part of Clark's never-ending program of product improvement.

Look At These Results! After testing various methods of surface treatment including flame hardening and shot peening, TOCCO induction hardening was selected because the average improvement in fatigue life was greater than with any other type of surface treatment. The improvement in fatigue life with TOCCO equipment is approximately 400%.

In addition to improved fatigue life, surface wear resistance and improved grindability are achieved.

Fatigue test consisted of loading axle housing on spring seats to approximately twice the rated load and stroking at 180 cycles per minute.

Hardening Process	Per cent Improvement In Fatigue Life Over Standard Production
Shot Peening	50%
Flame Hardening	300%
TOCCO Induction Hardening	400%

In your search for ways to improve your product to meet today's tightening competition, don't overlook TOCCO as a sound means of improving product quality, increasing production speed and lowering production costs.

THE OHIO CRANKSHAFT COMPANY

TOCCO

*Trade Mark Reg. U. S. Pat. Off.

Mail Coupon Today

NEW FREE BULLETIN

THE OHIO CRANKSHAFT CO.
Dept. Q-5, Cleveland 5, Ohio

Please send copy of "Typical Results of TOCCO Induction Hardening and Heat Treating."

Name_____

Position_____

Company_____

Address_____

City_____ Zone____ State_____

Doehler-Jarvis help REGINA floorwaxer

Waxing the floor once took plenty of elbow grease.

Now machines do the muscle work. Do it as you used to – bearing down . . . rubbing hard.

So a mechanical waxer needs a certain amount of weight – as well as speed.

And remember this! A floorwaxer's lot is not a happy one. It should be rugged. What's more, though it hides in a broom closet all its life, it has to look like a million on the sales floor. Compete pricewise, too.

One company . . . The Regina Corporation . . . has done an outstanding job of meeting these requirements. Today, something like four out of every five floor waxers sold are made by Regina.

Regina's methods are deceptively simple. Consider their use of Doehler-Jarvis zinc die castings for base, motor housing, handle swivel, and cover. This one policy, alone, accounts for many of the sales advantages their waxers enjoy.

Take weight! Zinc provides it . . . in just the right measure for efficient polishing combined with easy handling. Die casting helps Regina distribute weight evenly and concentrate it low for balance.

Take strength! Zinc has it and die casting exploits it . . . permitting metal to be concentrated where stresses accumulate, reduced or eliminated where strength requirements diminish or disappear.

Three of Four Big Sales Points stressed by Regina to dealers are founded on the use of Doehler-Jarvis zinc die castings . . . eye catching finish (good die-cast surfaces), efficient polishing action (well-placed weight), rugged serviceability (high-strength metal).

zinc die castings add weight to their sales story

Take appearance! Die-cast zinc surfaces enhance almost any finish you want to name . . . including the new enamels in pastel shades. To get a basic change in shape, as for a new model, Regina simply designs a new die-cast cover to fit.

Take cost! Regina and Doehler-Jarvis engineers work production costs down pretty far. In current models, machining is reduced to light reaming of the bearings, a combination turning operation and the tapping of three holes. Cast-in holes speed assembly with self-threading screws. To save still another operation, servicing instructions are die-cast in bas-relief letters.

There are important cost reduction implications, too, in Doehler-Jarvis service. Regina puts it this way, "We've done business with Doehler-Jarvis for over twenty years. We can count on prompt action when it's called for . . . and when they set up a shipping schedule they hold to it."

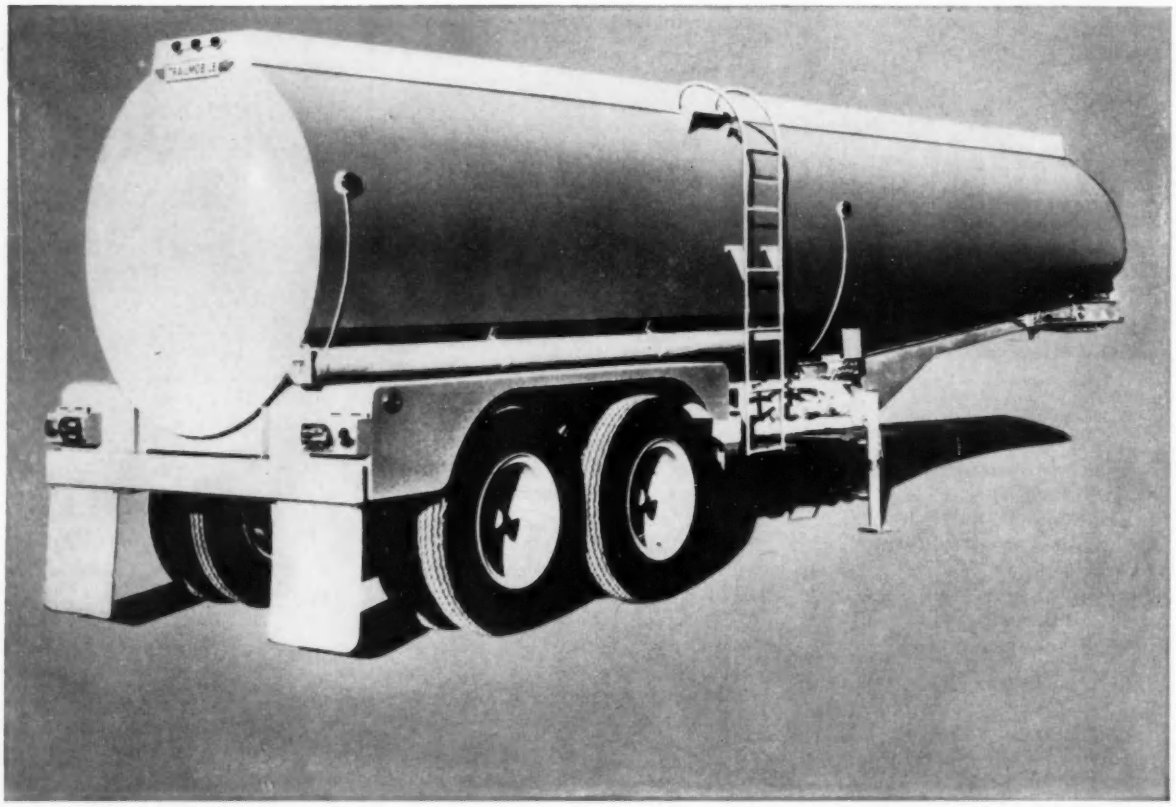
This practical type of relationship has been duplicated many times between Doehler-Jarvis and its customers. For Singer, Black and Decker, York, AMF, Underwood and many another blue chip company it's paid off again and again . . . just as it can pay off for you.

So if you are designing a new product or model, look into the possibilities of die castings . . . Doehler-Jarvis die castings.

Doehler-Jarvis
Division of National Lead Company
General Offices: Toledo 1, Ohio

In Canada:
Barber Die Casting Co., Limited
Hamilton, Ontario

*Reg. U. S. Pat. Off.



Most recent design of lightweight steel tank-trailer developed by the Tank Division, Trailmobile, Inc., at Springfield, Mo., where the unit is now in production. Designers stripped off needless weight by using USS COR TEN, a high-strength, low-alloy steel containing nickel, produced by United States Steel Corp., Pittsburgh, Pa.

2440 pounds trimmed off...

Use of high strength low alloy nickel-copper steel adds capacity to trailer

REDUCED OPERATING COST is one result of this weight reduction. There's less wear on tires and brakes. And fuel is saved every day.

Yet payload is up. Over-all strength of the unit is unchanged.

In place of hauling needless weight every trip, this tank-trailer can deliver 400 extra gallons of gasoline or 340 extra gallons of fuel oil. Either increases revenue per ton mile.

Engineers at Trailmobile, Inc. aimed for several advantages by using basic properties of high strength low alloy steel containing nickel. In thin light section, steels of this type provide the same strength as thicker, heavier sections of carbon steel. But reduction of deadweight is not the entire story.

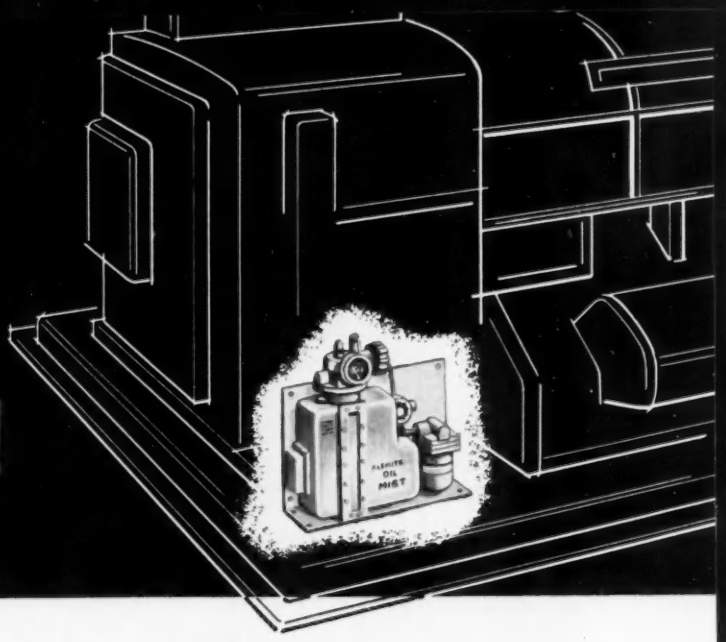
Offering high resistance to atmospheric corrosion . . . 4 to 6 times that of carbon steel . . . the nickel alloyed steels retain a high proportion of their original strength during years of use. This assures longer equipment life and cuts down maintenance and repair costs.

In addition, you'll find that high strength low alloy steels containing nickel can be hot or cold formed about as readily as mild carbon steels. Use of these steels helps to reduce unit labor cost as well as production time.

Produced under various trade-names by leading steel companies, high strength low alloy steels containing nickel along with other alloying elements, offer money-saving advantages. Learn more about these steels . . . send for a copy of "Nickel-Copper High Strength Low Alloy Steels." It discusses design factors, corrosion-resistance and the like. Write for it now.

INCO TRADE MARK **THE INTERNATIONAL NICKEL COMPANY, INC.** 67 Wall Street New York 5, N. Y.

save up to 90% on lubricating costs!



ALEMITE OIL-MIST AUTOMATIC LUBRICATION

multiplies bearing life...cuts product spoilage ...boosts machine output in almost every industry!

Alemite Oil-Mist Automatic Lubrication brings remarkable savings . . . in lubricants, man-hours, bearing life, and decreased product spoilage.

Alemite Oil-Mist *atomizes* oil into mist—distributes it through tubing to bearings—bathes all bearing surfaces with a cool film of clean oil. Maintains uniform oil film on plain and anti-friction bearings, gears and chains—despite variations in load, temperature or speed. Amazingly simple, continuous and fully automatic . . . Alemite Oil-Mist eliminates the waste and uncertainties of the "human element" in lubrication.

Let us show you how Alemite Oil-Mist provides more efficient, foolproof lubrication, at lower cost! Mail coupon below for a graphic demonstration!

8 ADVANTAGES of the ALEMITE OIL-MIST System

1. Continuous Lubrication—Constantly deposits fresh, clean film of oil on all surfaces of all bearings in the system.

2. Fully Automatic Lubrication—Can start and stop with operation of machine switch.

3. Elimination of Guesswork—No bearing can be over-looked, nor over-lubricated! Every bearing picks up only as much Oil-Mist as it needs.

4. Reduction of Bearing Temperatures—Acts as bearing coolant, can lower bearing temperatures as much as 20° F.

5. Reduction of Types of Oil—Reduces number of oils that must be stocked, handled, and applied.

6. Elimination of Downtime—All bearings in the system are constantly lubricated while machines continue to operate.

7. Extension of Bearing Life—Multiplies bearing life many times. Life of grinding machine bearings has been extended from 400 to 7,000 hours!

8. As High As 90% Less Oil Consumption—Alemite Oil-Mist usually consumes about 1/10 the amount consumed by any other oiling method!

Alemite Oil-Mist Lubricates ALL Types of Mechanisms

Anti-friction Bearings | Plain Bearings | Chain | Gear | Gear Cases

A PRODUCT OF SW STEWART WARNER

ALEMITE

REG U.S. PAT. OFF.

A Product of STEWART-WARNER CORPORATION

Alemite Division of Stewart-Warner, Dept. JJ-56
1850 Diversey Parkway, Chicago 14, Illinois

☐ Please send me a FREE copy of your new and complete Oil-Mist catalog.

☐ Please have your Alemite Lubrication Representative arrange a no-obligation demonstration.

My Name .....

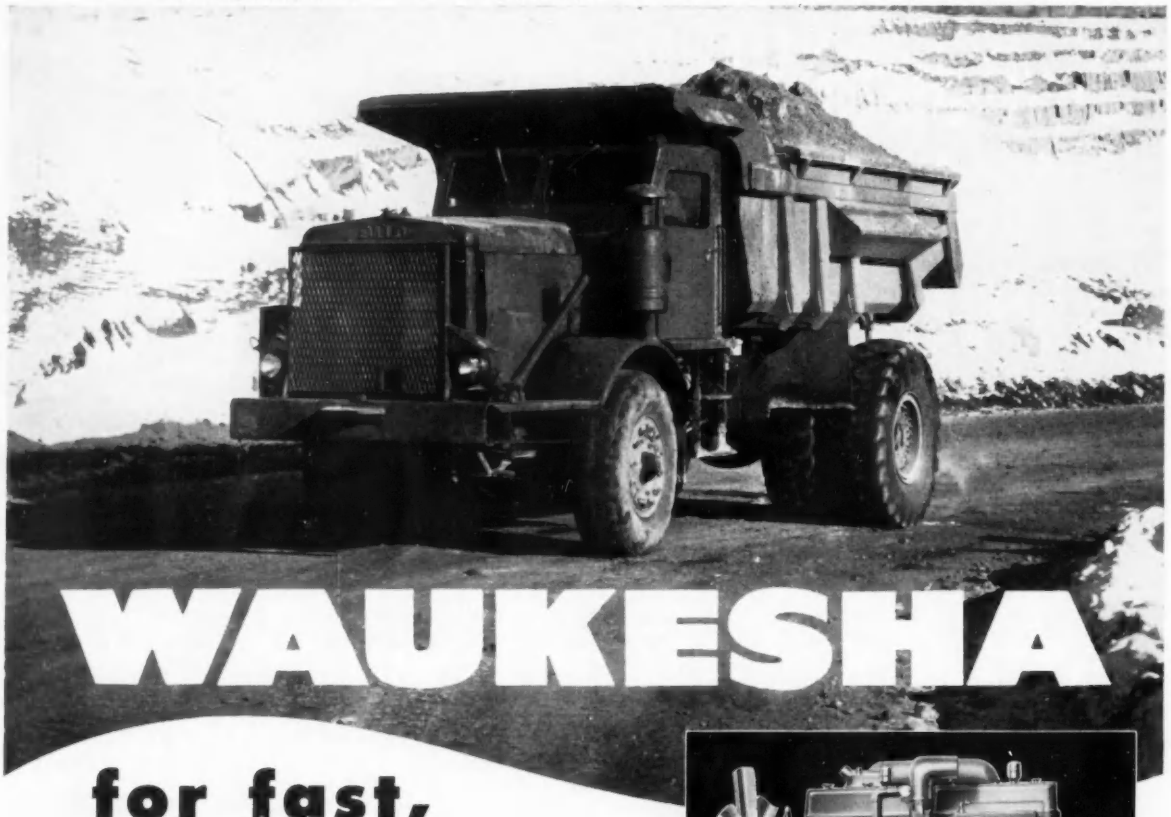
Title .....

Company .....

Street .....

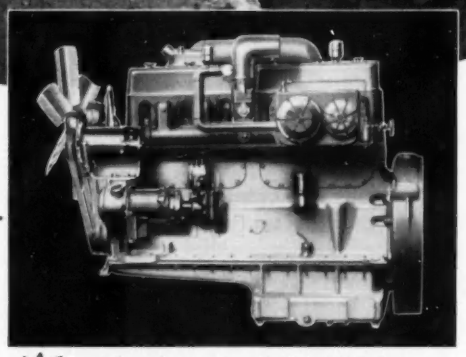
City ..... State .....

This fast traveling truck, powered with a Waukesha Super Duty Six, moves more material, most economically, in mining service.



WAUKESHA

for fast, heavy hauls



Powering the truck — Model WAKR Butane Super Duty Six—6¼-in. bore x 6½-in. stroke, 1197 cu. in. displacement, 290 horsepower at 1800 rpm.

1197 cubic inch Super Duty ENGINES

all with counterbalanced crankshafts

WAKR Butane — **WAKDB** Normal Diesel — **WAKDBS** Turbodiesel

up to 352 maximum hp

This truck is one of sixteen in a mining company's fleet. Hauling 22-ton average payloads—up 6 to 8 per cent grades—off-the-highway most of the time—and they work a twenty-hour day. Only after 7000 hours or more of this heavy hauling mine service are the engines overhauled—a good average.

Let's look at this truck's power. It has a torque converter—automatic transmission combination—and the engine is one of the Waukesha 1197 cubic inch Super Duty Sixes. This is Model WAKR, burning butane. Built like the Super Duty Diesels in this WAK Series, except for cylinder heads and injection equipment.

Write for descriptive bulletins

308

50th ANNIVERSARY Waukesha MOTOR 1906-1956

WAUKESHA MOTOR COMPANY • WAUKESHA, WIS.

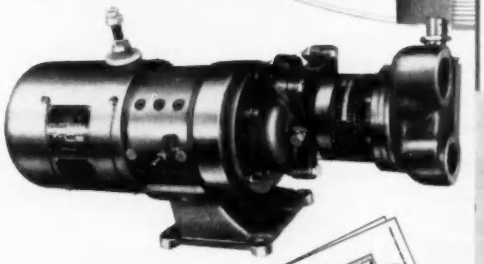
NEW YORK • TULSA • LOS ANGELES

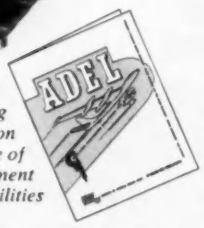
NEW
and GREAT
Prop Feathering
Pumps by ADEL

Making Props Behave... Propeller pitch control is a very important factor in starting, flying and landing modern transports smoothly and safely. These new Pumps, products of outstanding engineering abilities and facilities, provide Aircraft Manufacturers and Airlines that *extra* efficiency in Propeller performance.

Precision design and performance characteristics: HIGH CAPACITIES... LOW AMPERAGE... EFFICIENT OUTPUT AT SEA LEVEL AND ALTITUDE OPERATION... EFFICIENT RELIEF VALVE CHARACTERISTICS... EFFICIENT BLEED AND BLEED SHUT-OFF VALVE CHARACTERISTICS... COMPLIANCE WITH DUTY CYCLE AND ENDURANCE REQUIREMENTS. MEET OR EXCEED ALL APPLICABLE AIRCRAFT SPECIFICATIONS.

Making Props Behave
Proven *Quality* costs no more... *Specify* ADEL



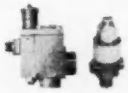


Write for descriptive Brochure containing detailed information on ADEL's *line of Aircraft Equipment and facilities*

ADEL
PRECISION PRODUCTS
A DIVISION OF GENERAL METALS CORPORATION

BURBANK, CALIFORNIA · HUNTINGTON, WEST VIRGINIA
CANADA: RAILWAY & POWER ENGINEERING CORPORATION, LIMITED

ADEL designs and manufactures aircraft accessories in the following major categories:

HYDRAULIC & PNEUMATIC CONTROL EQUIPMENT 

ANTI-ICING, HEATER & FUEL SYSTEM EQUIPMENT

ENGINE ACCESSORIES

LINE SUPPORTS

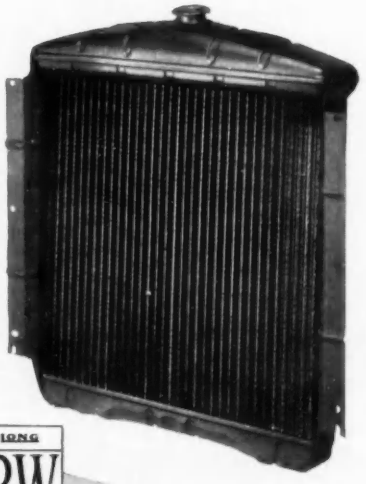
Installation of the most modern equipment, doubling our engineering and other specialized personnel are but some of the factors contributing to our newly increased productivity and efficiency.

Long's experience in quality manufacture includes over a half century of volume production for American industry. The progressive policies of Borg-Warner—of which we are a Division—set new goals in expanding our engineering and production service.

We direct you to the advantages of meeting your cost and delivery requirements through recent developments and new applications of our products. We're eager to tell you about them in detail.

NEW LONG RADIATOR BOTTOM TANK OIL COOLER

Simply and economically placed in the lower tank of the radiator this new Long-designed oil cooler in one neat out-of-the-way package maintains desired oil temperature for engine and/or transmission. They are available in a variety of lengths, thicknesses and multiple wafers, and are now in volume production at Long.



LONG-BUILT RADIATORS

Long radiators make the most efficient use of material and provide a more rugged construction at competitive prices. Long's outstanding engineering facilities are available to you for design and building of any type of radiator or heat exchanger.

LONG B-W BORG-WARNER

LONG ®

LONG MANUFACTURING DIVISION, BORG-WARNER CORPORATION

12501 DeQuindre Street, Detroit 12, Michigan

Also: Windsor and Oakville, Ontario

THE STANDARD OF QUALITY AND PERFORMANCE SINCE 1903

VW | *This is the fifteenth of a series of advertisements dealing*

the new vinyl-to-metal laminating process?

Seat backs and frames

Larger families... more rough 'n tumble in the back seat.
Smaller taxicabs... more knocks and scrapes from suitcases and boxes.
Increased stationwagon registrations... more scuffs and bruises from bigger, shifting packages.

These three trends emphasize the importance of new protective materials like Marvibonded metals. Marvibond* is the new laminating process that permanently bonds vinyl sheeting to practically any kind of metal.

Marvibond vinyl-to-metal laminates...

- **can't rust, rot or corrode!**
- **are attractive, pleasant to touch!**
- **can't chip, crack, or craze!**
- **are scuff- and stain-resistant!**
- **are clean, comfortable, easy to maintain!**

Prefinished sheet metal! Marvibonded metals are laminated before forming. Neither finish nor bond is affected by bending, crimping, drilling, embossing, punching, or drawing.

Practically any surface effect! High finish or matte finishes, leather-like grains, marble patterns, prints, weaves, and sculptured appearances can be achieved economically.

Marvibonded laminates can be used where sheet metal is used... dashboards, window trim, door panels, truck cabs, and other automotive interior components. So, why not consider what the Marvibond process offers in beauty, protection, serviceability, extra sales impetus and real production economies? For technical data and samples, and the names of licensed Marvibond laminators in your area, please write—

*Patent applied for

United States Rubber
Naugatuck Chemical Division
Naugatuck, Connecticut

BRANCHES: Akron • Boston • Gastonia, N.C. • Chicago • Los Angeles • Memphis • New York • Phila.
IN CANADA: Naugatuck Chemicals, Elmira, Ontario • Rubber Chemicals • Synthetic Rubber • Plastics • Agricultural Chemicals • Reclaimed Rubber • Latices • Cable Address: Rubexport, N.Y.

XV

This is the fifteenth of a series of advertisements dealing with basic facts about alloy steels. Though much of the information is elementary, we believe it will be of interest to many in this field, including men of broad experience who may find it useful to review fundamentals from time to time.

Boron and Its Effects in Alloy Steels

Boron is a nonmetallic element of which this country has a plentiful supply. In its natural or unprocessed state it occurs only in combination, as in borax, etc. Pure boron is a gray, extremely hard solid with a melting point in excess of 4000 deg F.

This element is used in steel for one purpose only—to increase hardenability; that is, to increase the depth to which the steel will harden when quenched. Its effective use is limited to sections whose size and shape permit of liquid quenching. Only a few thousandths of 1 pct is ordinarily added, and boron steels are evaluated by increased hardenability rather than chemical content. A number of alloys, including several grades of ferroboron, are available for adding boron to steel.

Boron intensifies the hardenability characteristics of other elements present in the steel. It makes possible a considerable degree of alloy conservation when used with steels containing small amounts of alloying elements. However, since it readily oxidizes at high temperatures, some steelmakers prefer a melt with relatively low boron content and relatively high contents of other elements that protect the boron from oxidation.

It should be noted that boron is very effective when used with low-carbon alloy steels; but its effect is reduced as the carbon increases. When the carbon content is above 0.60 pct, the use of boron is not suggested, the exception being the "case" in those steels that are carburized.

Boron steels often require closer temperature control in heat-treatment than do some of the other alloy analyses; but aside from this they present no special problems. Their cold- and hot-working properties are considered at least equal to those of ordinary alloy steels. In cases where boron makes possible a lower alloy content, improved machinability frequently results.

If you would like to know more about boron and its effects in alloy steels, you are invited to consult with Bethlehem's metallurgical staff. Our technicians will gladly give you all the information you need, and will work closely with you in every respect. And when it is time to replenish supplies of steel, remember that Bethlehem manufactures the full range of AISI standard alloy grades, as well as special-analysis steels and all carbon grades.

If you would like a reprint of this advertisement, or of the entire series from I through XV, please write to us, addressing your request to Publications Dept., Bethlehem Steel Company, Bethlehem, Pa.

BETHLEHEM STEEL COMPANY
BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. *Export Distributor:* Bethlehem Steel Export Corporation

BETHLEHEM STEEL

BETHLEHEM STEEL

UNITED

Rectangular Diesel Air Cleaner Helps Crawler Tractors Breathe Easily

This new United Specialties rectangular diesel oil bath air cleaner provides major improvements in air cleaner design and operation. It is available for truck and tractor engines, and for industrial power units.

1. Meets Limited Space Requirements

Rectangular shape of air cleaner conforms better to engine shape — fits snugly under hood — makes most efficient use of available space.

2. Lower Installation Cost

Air cleaner outlet can be taken at any point around the perimeter of the clean air chamber, providing the shortest connection to manifold.

3. More Air Volume

The rectangular cleaner, with sides of the same length as the diameter of a circular cleaner, contains far more surface area. This helps slow down air velocity through cleaner, safeguards against oil carryover from cleaner to engine.

4. Simple Maintenance

Removable scrubber element can be easily detached for cleaning.

For the newest and finest in oil bath air cleaner protection, call on United Specialties. Our experienced sales engineers can help you with your air cleaner design problems. We invite your inquiry.

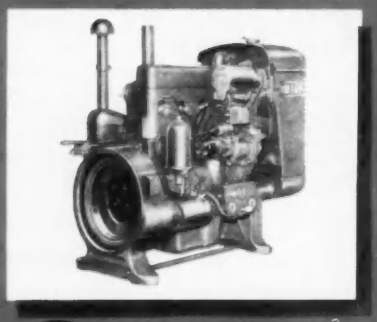
UNITED SPECIALTIES COMPANY

UNITED AIR CLEANER DIVISION — CHICAGO 28, ILL.
MITCHELL DIVISION — PHILADELPHIA 36, PA. • BIRMINGHAM, ALA.

Air Cleaners · Metal Stampings · Rolled Shapes · Ignition Switches · Turn Signal Switches · Dovetails

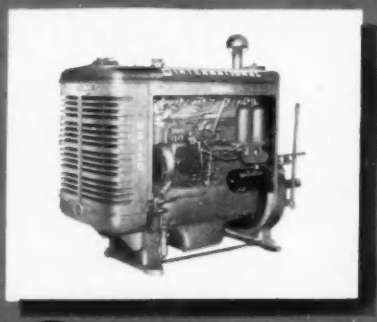
To get the advantages that only 54 years of engine standardize on International®

Here are 5 typical members of the International family of 18



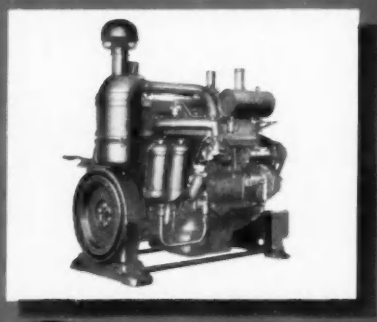
U-169

U-169, rugged 4-cylinder 48.6 hp valve-in-head carbureted unit, delivers top performance on "regular" gasoline. Can be adapted to burn LPG, natural gas, kerosene, or distillate. Ideal for compactors, ⅜-yd excavators, water well drills, fork lifts, rotary snow plows, 12 to 15 kw generators.



UD-350

UD-350, 4-cylinder diesel develops 78.5 bhp as an engine, 75 bhp as a power unit shown above. Available in air compressors, bucket loaders, asphalt mixers and driers, ½-yd shovels and cranes, portable screening plants, 25 to 40 kw generators, hoists, graders, pumps, and trenchers.



UD-525

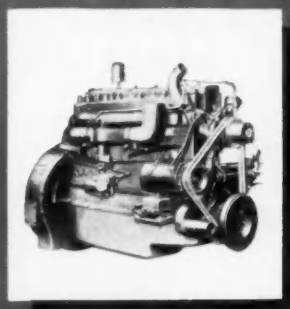
UD-525, 6-cylinder, 121 bhp diesel with all-weather push-button starting as standard equipment. Available with 14 major attachments, including 43-gal fuel tank, muffler, skid-type subbase. Fits 29 different excavators, graders, compressors, other construction tools.

International power units in various modifications are engineered to team with all these machines:

Shovels, Cranes, Draglines 17 Manufacturers	**Crushers** 5 Manufacturers
Motor Graders 5 Manufacturers	**Fork Lifts** 3 Manufacturers
Air Compressors 5 Manufacturers	**Generators** 5 Manufacturers
Road Rollers 4 Manufacturers	**Trenchers** 3 Manufacturers
Asphalt Mixers and Pavers 6 Manufacturers	**Pumps** 12 Manufacturers

leadership can give . . .

Engines



U-450

U-450, one of the most popular 6-cylinder carbureted engines on the market today for trucks, water well drills, 35 to 50 kw generators, graders, ¾-yd shovels and draglines, big rotary snow plows, ditchers and trenchers. Develops 118.5 belt horsepower.

UD-1091

UD-1091, diesel, largest of the 18 International engines, develops 214 bhp, provides exceptional fuel economy for 34 different makes of construction units, including 2 to 2½-yd shovels, 8-cylinder compressors, large asphalt plants and 75 to 100 kw generators.

Engine Model	Displacement (Cubic Inches)	Horsepower (with full equipment less fan)
CARBURETED ENGINES		
U-1	60	17 @ 2500
U-123	123	31.2 @ 2000
U-169	169	48.6 @ 2000
U-264	264	53.5 @ 1600
U-220	220	64 @ 2400
U-240	240	66.5 @ 2400
U-282	282	79 @ 2400
U-372	372	96.5 @ 2200
U-406	406	104 @ 2200
U-450	450	118.5 @ 2200
U-1091	1091	214 @ 1600

Engine Model	Displacement (Cubic Inches)	Horsepower (with full equipment less fan)
DIESEL ENGINES		
UD-264	264	57.5 @ 1800
UD-350	350	78.5 @ 1800
UD-14A	461	100 @ 1800
UD-525	525	121 @ 1800
UD-140-D	525	141 @ 2300
UD-18A	691	131.5 @ 1600
UD-1091	1091	214 @ 1500

In most fields, you'll probably agree, you get the most for your money from the company that's been a leader *for the longest time.*

In engines and power units, the outfit to turn to for longest leadership is International. Since starting manufacture in 1902, International has built and sold *millions of engines* for heavy-duty work! In these 54 years, International has pioneered in developing and perfecting many of the features you consider essential today. Valve-in-head design . . . all-weather diesel starting . . . replaceable cylinder sleeves . . . tocco hardening . . . lubrication through drilled passages . . . precision type bearings . . . full-flow oil filters, to name a few.

These cost-cutting features are backed up with such added advantages as:

Honest horsepower ratings at speeds you can use.

Easy installation with attachments to fit whatever jobs you have.

Fully-experienced sales engineers to help you select and install the engine which best does your work.

Unmatched adaptability, with the same basic engine available as regular or optional power with various modifications in many kinds of equipment (one typical International engine, for instance, fits an International crawler tractor *and 46 makes* of loaders, compressors, asphalt mixers, pavers, excavators, generators, pumps, graders, and rollers). When you power with International, this ready adaptability lessens your parts inventory . . . simplifies and speeds operator training . . . makes your servicing problems a lot easier!

International engine owners get another tremendous benefit, too. To help them is one of the most experienced heavy-duty engine parts and service organizations in the world. At your service are 11 giant regional *parts depots*, 173 Industrial Power *Distributor* locations, *and* hundreds of Power Unit *Dealers*.

To get all these big profit-making advantages, be sure to specify International power. See your nearest Distributor or Dealer for all the facts.

INTERNATIONAL HARVESTER

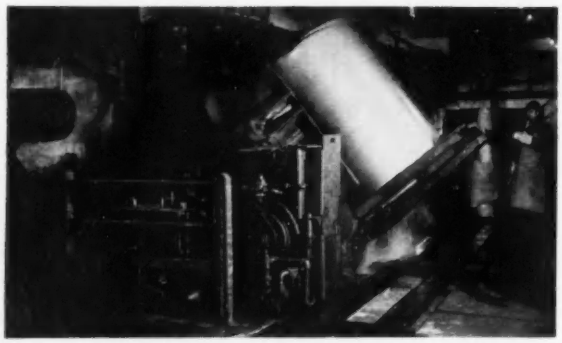
International Industrial Power

180 N. MICHIGAN AVENUE—CHICAGO 80, ILLINOIS

A COMPLETE POWER PACKAGE INCLUDING: Crawler, Wheel, and Pipe-Boom Tractors . . . Self-Propelled Scrapers and Bottom-Dumps . . . Tractor and Rubber-Tired Loaders . . . Diesel and Carbureted Engines

How Great Lakes Steel *guides* quality

FIRST QUALITY CHECK is made at No. 1 Mill Stand. Here, an electronic pyrometer relays the strip's temperature to the panel.



FINAL CHECK in this operation is made at the coiler. From slab to coil, the control panel spells far better quality.

Here's one of several electronic operation panels that take the guesswork out of quality control at Great Lakes. You'll find this one guiding the entire operation of the 96-inch continuous mill.

As the red-hot strip races from roll stand to roll stand and on to the coiler, the temperature, speed, width and thickness of the strip *at each stage* are instantly shown on the panel.

A glance at the panel tells the operator if any adjustments are necessary to assure a finished product of the highest quality—a product that will stand the rigid test of your specifications.

This is further proof that Great Lakes has what it takes—the experience and the very latest equipment—to make your product even better. Our representative is just one telephone call away.

GREAT LAKES STEEL CORPORATION

Ecorse, Detroit 29, Michigan • A Unit of

NATIONAL STEEL CORPORATION

District Sales Offices: Boston, Chicago, Cincinnati, Cleveland, Grand Rapids, Houston, Indianapolis, Lansing, Los Angeles, New York City, Philadelphia, Pittsburgh, Rochester, St. Louis, San Francisco, Toledo, Toronto.

It's 196X in your engine lab...

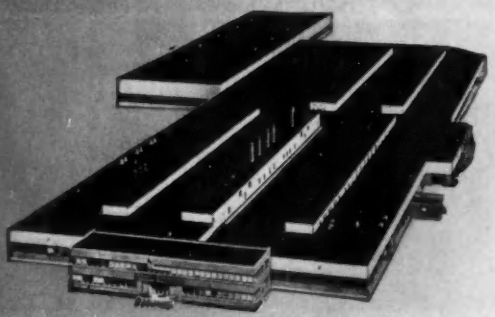
New alloys and improved valve geometry are being developed now at the Valve Division to meet the valve-train requirements of your 196X engines.

For example...Thompson MS-201 is a new service-proved low-nickel alloy developed to be the hardest, most burn-resistant austenitic valve alloy available. MS-201 is the latest in the Thompson-developed family of valve alloys that began with the famous Thompson silcrome steel back in the 1920's.

Another example, 3 types of valve rotation systems to add thousands of extra miles to the valves in your high-performance engines.

Thompson is continually experimenting with new and better valve steels, and valve-train components to keep valve engineering apace of engine developments.

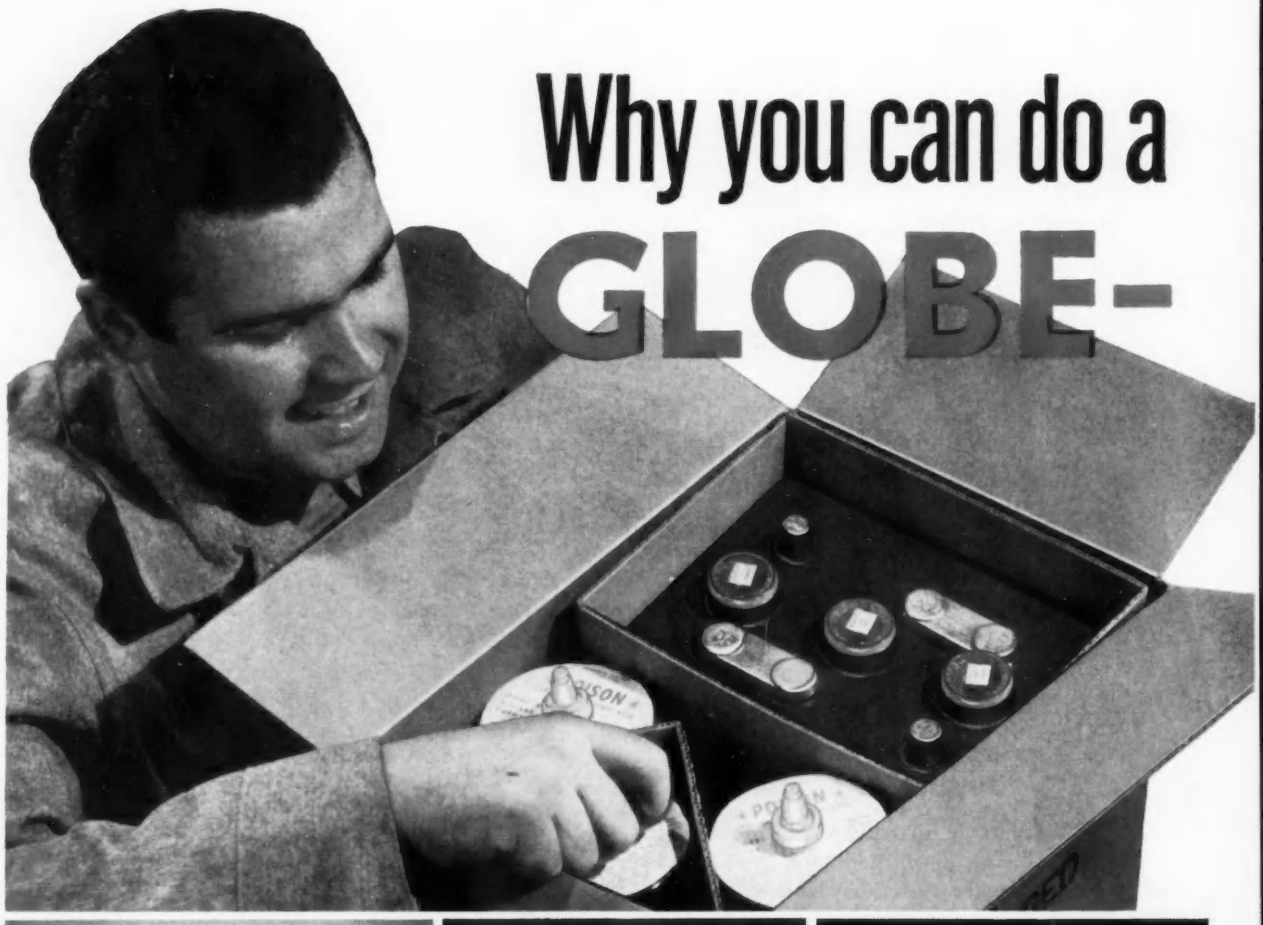
and at our valve plant



Valve Division Thompson Products, Inc.

1455 EAST 185th STREET • CLEVELAND 10, OHIO

Why you can do a GLOBE-



MERCHANDISING DISPLAYS THAT SELL — Cartons for Globe dry-charged batteries have plenty of eye appeal . . . lend themselves to striking displays. Even the most casual store or station traffic is "stopped" . . . get a friendly but insistent reminder that it's time to have his battery checked.

ONE COMPACT, "ALL-ITEM" CARTON — When a Globe dry-charged battery is delivered, one carton contains "the whole ball of wax" — battery, electrolyte containers and safety sleeve for handling electrolyte bottles. There's no need to cross-check inventory . . . look up various items in different storage areas.

STRONG, BUT LIGHTWEIGHT ACID BOTTLES— Much lighter in weight than glass bottles, Globe plastic containers have greater shock or impact resistance. There's little if any chance for them to break. And they cost less to ship . . . are easier to handle and pour than most other types of disposable containers.

13 of Globe-Union's strategically-located battery plants assure fast, efficient, low-cost delivery of dry-charged batteries.

Atlanta, Ga.	Memphis, Tenn.
Dallas, Texas	Milwaukee, Wis.
Emporia, Kansas	Mineral Ridge, Ohio
Houston, Texas	Philadelphia, Pa.
Louisville, Ky.	Reidsville, N. Carolina
Medford, Mass.	San Jose, Calif.

Hastings-on Hudson, N. Y.

better merchandising job with BUILT dry-charged batteries!

Today's newest, finest dry-charged batteries are a better buy for both you and your customers...

Now from Globe-Union — makers of the world's finest and most dependable batteries — here's a "dry-charged" that's as easy to activate as it is to sell!

Naturally — this new line of batteries helps you carry a complete inventory... a battery to meet the needs of any petroleum-powered automotive or farm equipment.

But more than that—NEW GLOBE-UNION DRY-CHARGED BATTERIES OFFER YOU EASE OF HANDLING AND STOCKING THAT'S UNMATCHED BY ANY OTHER BATTERY PACKAGE!

Creative Packaging

...sparks sales
...makes activation safe
...easy...quick

PRE-MEASURED, READY-TO-POUR ELECTROLYTE Electrolyte for Globe dry-charged batteries is closely controlled for exact specific gravity. Also, metered filling of bottles insures the correct amount for each battery. Merely cut off spout at line indicated and bottle is ready to use.

SAFE AND EASY TO HANDLE — Though caution is urged, Globe's practice of including an acid bottle handling sleeve in each carton lessens chance for spillage and damage. As a reminder, activation instructions are also printed on each sleeve.

NO NEED TO STORE OR RE-FILL BOTTLES — Globe plastic containers for electrolyte are disposable. Merely rinse out and destroy. There's no re-filling, no empties to store, no chance for old acid bottles to be mistakenly used for other purposes.

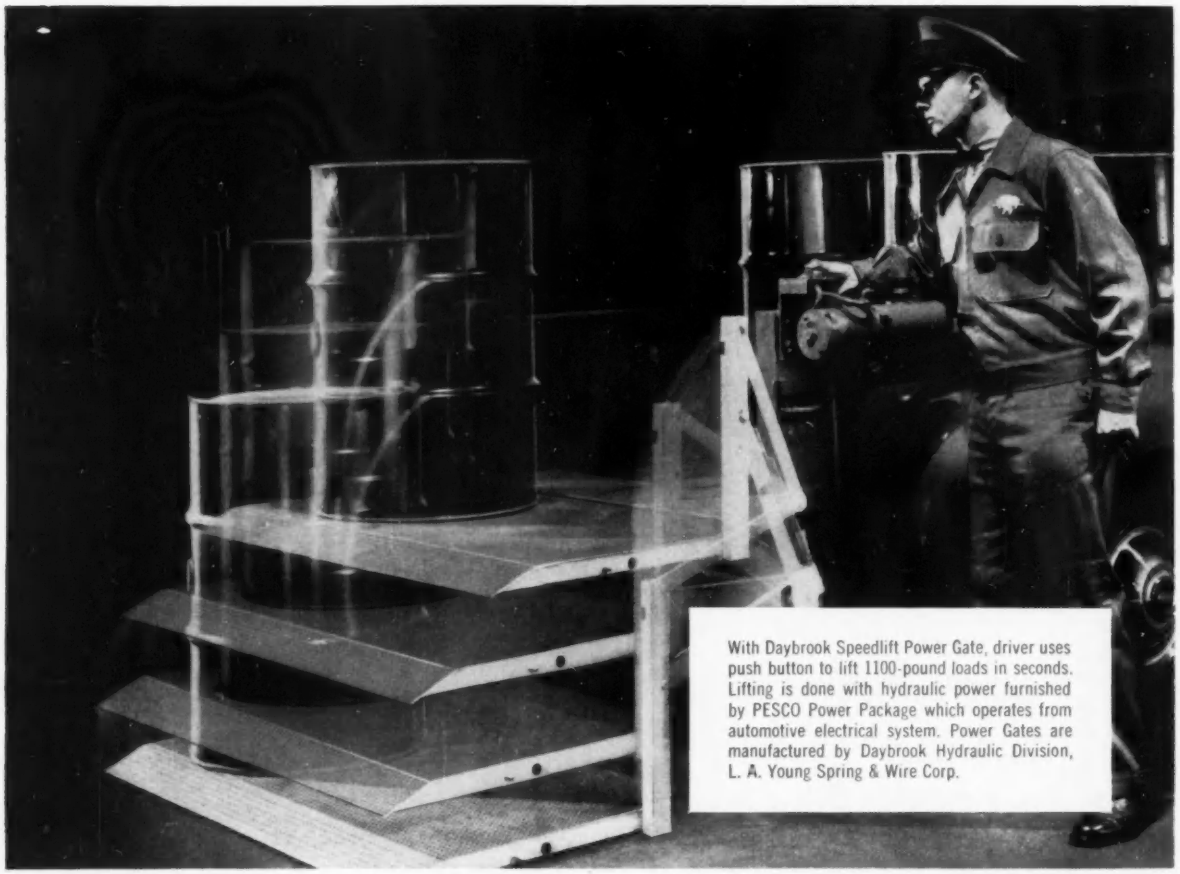
Wherever you are, there's a Globe battery plant nearby. You're assured of prompt help with any battery problems... quick, inexpensive delivery on battery shipments. Plants circled are those equipped for dry-charged battery production.

Globe dry-charged batteries are now available! The way they're built, the way they're packaged is further demonstration of Globe-Union's dynamic and creative engineering. For complete details, contact your Globe sales representative or write direct.

GLOBE-UNION INC.

MILWAUKEE 1, WISCONSIN

if it's petroleum-powered, *there's a GLOBE-BUILT BATTERY right from the start*



With Daybrook Speedlift Power Gate, driver uses push button to lift 1100-pound loads in seconds. Lifting is done with hydraulic power furnished by PESCO Power Package which operates from automotive electrical system. Power Gates are manufactured by Daybrook Hydraulic Division, L. A. Young Spring & Wire Corp.

hydraulic power at the push of a button

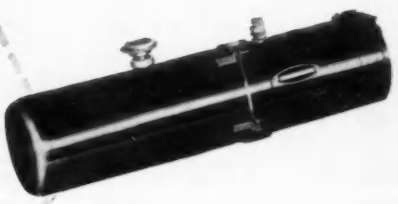
...with self-contained Pesco package

If you need to produce hydraulic power from an electrical source, investigate PESCO's line of Hydraulic Power Packages.

These low-cost units are versatile and find extensive application on tailgate loaders, lift trucks, small dump bodies, farm tractors and snow plows. They provide hydraulic flow to .80 gpm at pressures to 2000 psi from any suitable 6, 12 or 24-volt d-c source.

PESCO Hydraulic Power Packages include an electric motor, hydraulic gear pump with integral relief valve, check valve and reservoir in a single, self-contained assembly. The PESCO gear pump features "Pressure Loaded"* bearings for higher volumetric efficiency and longer service life.

Original equipment manufacturers are invited to obtain price quotations or specific information from your nearest PESCO sales engineer or write: PESCO, 24700 North Miles Road, Bedford, Ohio.



PESCO HYDRAULIC POWER PACKAGE converts electrical power to hydraulic, finds wide industrial use. Compact "package" design contains motor-driven gear pump, relief and check valves and reservoir.

See our catalog in Sweet's Product Design File

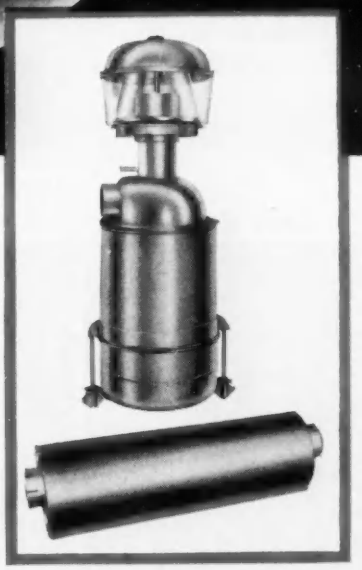
PESCO PRODUCTS DIVISION
BORG-WARNER CORPORATION
24700 NORTH MILES ROAD • BEDFORD, OHIO

Producing the Best in Hydraulic Pumps, Fuel Pumps, Electric Motors and Axial Flow Blowers

**PESCO's patented principle of gear pump construction*

On most of the world's power equipment . . . .

Donaldson Air Cleaners and Mufflers



The U. S. and Canadian manufacturers represented by these famous trademarks produce most of the world's heavy-duty engines, trucks, tractors and power equipment.

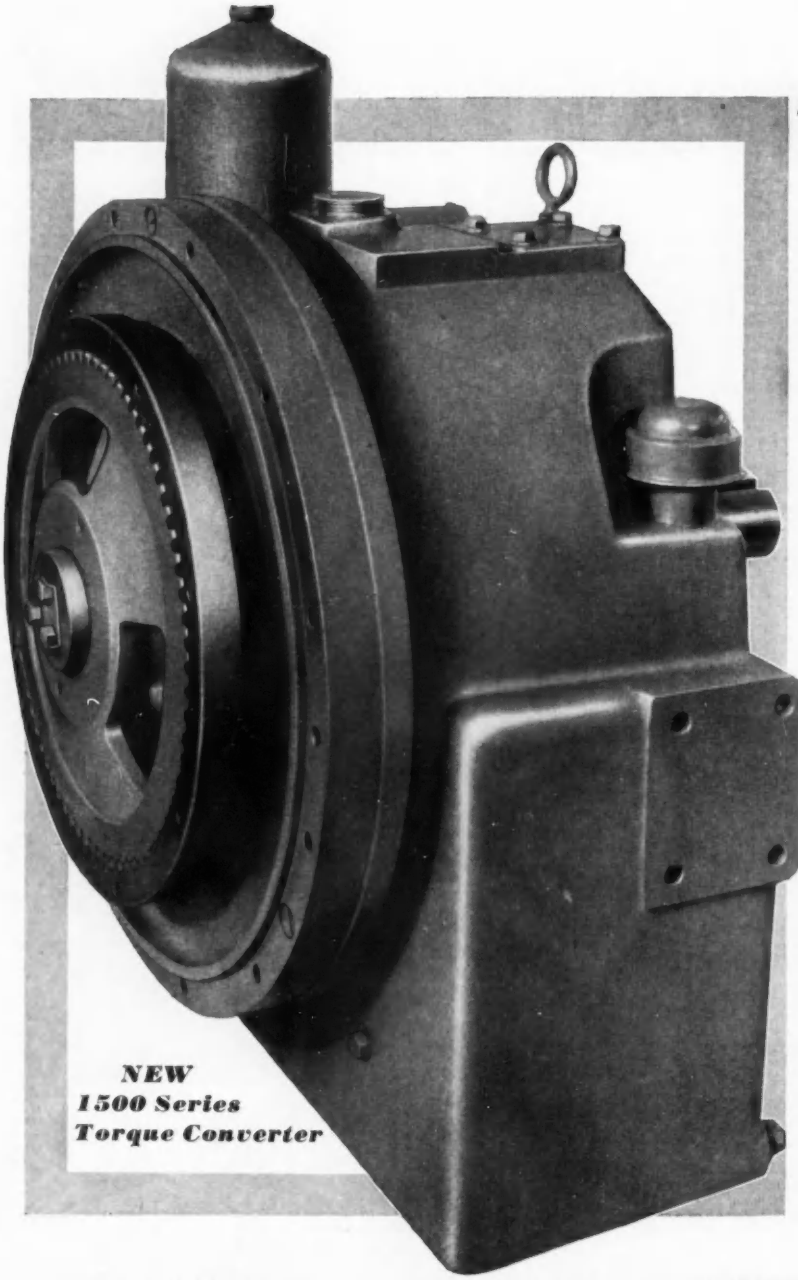
Most of them have equipped their units with Donaldson Air Cleaners from the time dust was first recognized as a serious threat to the progress of power.

The performance of Donaldson Air Cleaners and Mufflers under all conditions, Donaldson research and engineering, and efficient Donaldson production . . . are all parts of the "Follow-Through" service package which has made Donaldson a world leader in heavy-duty air cleaners and mufflers.

DONALDSON COMPANY, INC.

666 Pelham Boulevard — St. Paul 14, Minnesota

Grinnell, Iowa • Oelwein, Iowa • DONALDSON COMPANY (Canada) Ltd., Chatham, Ontario



Twin Disc

the world's largest manufacturer of industrial torque converters

Now! . . . Twin Disc offers a new line of *single-stage* torque converters, making Twin Disc the only manufacturer supplying both three-stage and single-stage units.

The new line of single-stage torque converters is the result of years of intensive engineering and field testing. It is of Twin Disc design and construction throughout and is not licensed from any other manufacturer, foreign or domestic.

Horsepower Range—Currently available in the 1500 Series, the new torque converter is applicable to engines producing from 30 hp at 1150 rpm to 198 hp at 2400 rpm. (See Fig. 5 for complete input hp and speed capacity range.)

Torque Capacity—Impeller bladings are available for specific torque

Fig. 1. Model "C"

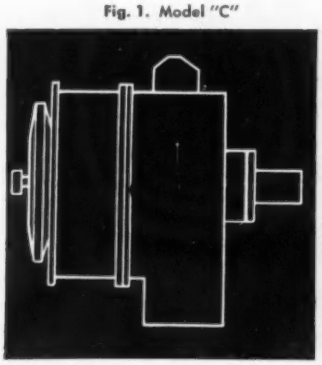


Fig. 2. Model "S"

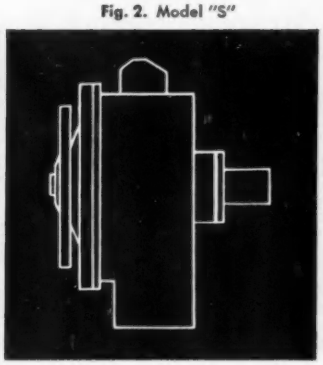


Fig. 3. Spacer-Type Model "S"

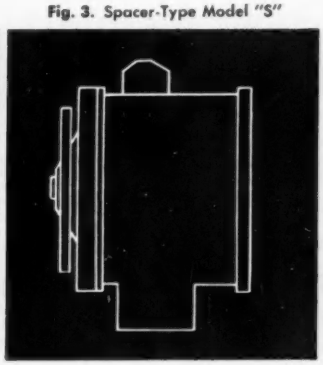
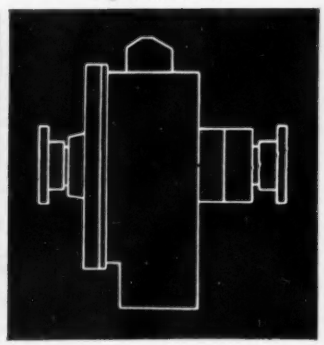


Fig. 4. Model "U"



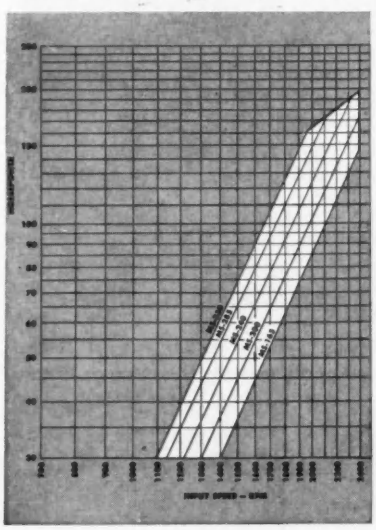
Announces new line of Single Stage Torque Converters

ratings of 165, 200, 240, 285 and 330 pound-feet.

Unloading Feature — The new Twin Disc single-stage unit features "unloading" of the engine through an exclusive blade design wherein the turbine develops a counter-head at high speed ratios, thus stopping fluid circulation. Unloading feature eliminates conventional free-wheeled stators . . . simplifies design and construction . . . makes for more trouble-free operation in the field.

One Housing, One Set of Components — Impellers having different bladings (both number of blades and pitch) are interchangeable. Thus torque capacities can be matched as accurately as possible to engines of various hp outputs and speeds without requiring changes in the converter housing or other components. Interchangeability means savings in production costs . . . savings to the customer.

Fig. 5. Horsepower and rpm capacity of the 1500 Series Single-Stage Torque Converter



Models — The new 1500 Series includes four models: (1) Model "C," with clutch input; (2) Model "S," with spider drive input; (3) the Spacer-Type Model "S," with double-ended SAE housing; and (4) Model "U," with flange input and flange output. (See Figs. 1, 2, 3 and 4 for model illustrations.)

Clutches — Model "C" arrangement is offered with either Twin Disc SP-111 or SP-114 Clutch . . . an economy feature permitting use of a smaller, more closely matched clutch for engines in the lower hp range. The spider on the Model "S" unit uses the same drive ring as the SP-111 Clutch. Therefore the same flywheel can be used.

SAE Housings—SAE No. 2 and No. 1 flywheel housings are available for both Model "C" and Model "S" units. Where the Model "C" is equipped with the SP-114 Clutch, only the SAE No. 1 housing can be used. On the double-ended Spacer-Type Model "S," No. 2 to No. 2 and No. 1 to No. 2 housings can be furnished.

Applications—Ideal for shovels, front-end loaders, bucket loaders, industrial lift trucks and other applications where single-stage torque converters offer certain advantages.

Introduction of the new 1500 Series Single-Stage Torque Converter is one more milestone in Twin Disc's long-established reputation as the world's largest manufacturer specializing in both fluid *and* friction drives for industrial applications.

Three-stage, and *now* single-stage torque converters, fluid couplings and friction power take-offs . . . Twin Disc makes them all. Whatever your drive problem, consult Twin Disc . . . for Twin Disc can recommend and furnish—*without bias*—the best drive for your application.

For further information, write today to Twin Disc Clutch Company, Hydraulic Division, Rockford, Ill.

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CLUTCHES AND HYDRAULIC DRIVES

TWIN DISC
Torque Converters

TWIN DISC CLUTCH COMPANY, Racine, Wisconsin • HYDRAULIC DIVISION, Rockford, Illinois
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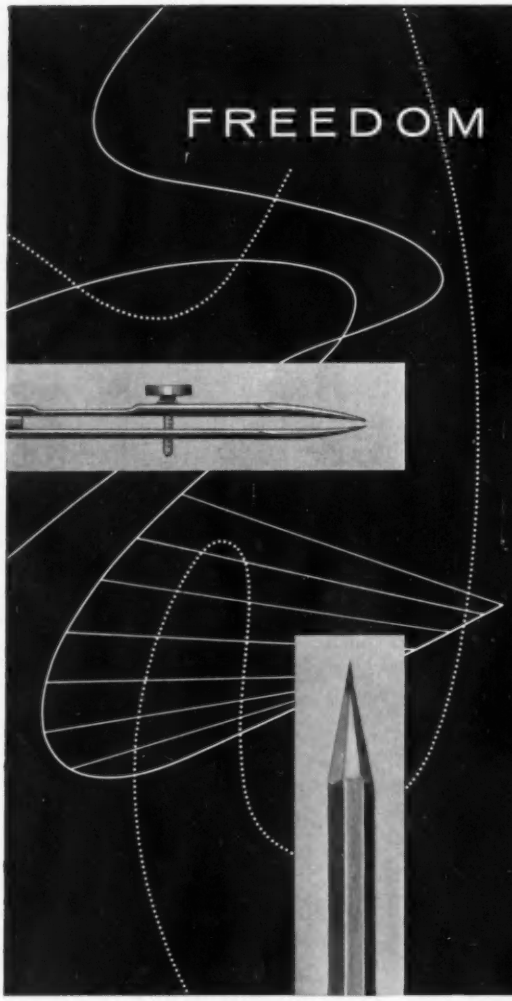
FREEDOM OF DESIGN

with Inland Self-Sealing Weather Strip



Inland Self-Sealing Weather Strip, with the separate filler strip, simplifies the design job, permits freedom for creative designing. No provision need be made for moldings, channels, binder strips or cement when designing with Inland Weather Strip.

You'll find that wherever Inland Weather Strip goes in, water stays out . . . in cars, buses, trucks, planes, trains, other over-the-road vehicles . . . in large and small boats that fight heavy seas . . . in factories, stores, theaters, hotels, homes, hospitals and many other structures. In fact, you'll find it wherever fixed windows of any size or shape must be positively sealed!

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self-sealing weather strip
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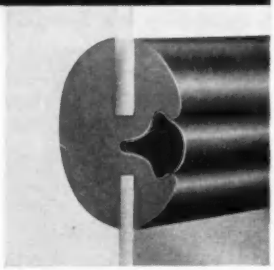

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SPECTOR ...Chicago's largest... standardizes on Fuller ROADRANGERS®

Spector Freight Systems, Inc., largest common carrier with home offices in Chicago, is adding 104 new tractors equipped with R-46 ROADRANGERS to bring a total of 257 ROADRANGER equipped tractors to its fleet.

Referring to Spector's 149 tractors now equipped with Fuller 8-speed ROADRANGERS, to 4 tractors equipped with 10-speed ROADRANGERS . . . and to the 104 new units with 8-speed Model R-46 ROADRANGERS, C. L. Lunt, Vice President, Operations, says:

"We have standardized on the ROADRANGER Transmission for better over-all fleet performance and less maintenance . . . resulting, of course, in a substantial dollar savings. Also, our drivers overwhelmingly prefer the semi-automatic Fuller ROADRANGER Transmission."

C. L. Lunt, Vice President, Operations

Spector, whose gross revenues rose from $1½-million in 1945 to an estimated $21-million in 1955, *knows* the value of better over-all fleet performance. Spector drivers prefer ROADRANGER 8 and 10-speed Semi-Automatic Transmissions with:

- **Easier, quicker shifts—all forward speeds in short closely spaced steps between ratios**
- **One shift lever that controls all forward speeds**
- **No gear splitting—all selective gear ratios are evenly and progressively spaced**
- **Higher average road speeds—engines operate in peak hp range with greater fuel economy**
- **Less driver fatigue—⅓ less shifting**
- **Range shifts pre-selected—automatic and synchronized**

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Compact space-and-weight-saving economies permit more cargo to be carried on payload axles. Get full facts on ROADRANGER from your truck manufacturer or truck dealer, now!

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The Stainless Steel trim, molding and vital parts that add style and beauty to a car, inside and out, are features that help make the sale.

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The question is directed to manufacturers whose cars are not yet equipped with Stromberg Carburetors. Car makers using Stromberg now are also using its outstanding economy record in the Mobilgas Economy Run to convince thousands of economy-minded customers.

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Stromberg-equipped cars have won the coveted Sweepstakes Award in this national economy tournament two straight years!

If economy is a touchy subject instead of a good, solid selling feature with your line of cars, it will pay you to make comparative efficiency tests with Stromberg Carburetors against the field.

Remember, for more than forty years more advances in carburetion have been initiated by Stromberg than any other manufacturer. Stromberg application engineers are at your service.

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for more current per circuit... more power per dollar

Anaconda specifies Enjay Butyl insulation for high-voltage cables because this rubber has incredible resistance to ozone. Surpassing the industry's standard three-hour specification test, Enjay Butyl insulation used by Anaconda showed *no injury after 72 hours* of ozone concentration tests—24 times longer than specification requirements. Other rubbers would deteriorate and crack in a fraction of this time.

With the help of Enjay Butyl, millions of feet of Anaconda's cable now in use deliver more current per circuit, more power per dollar.

Perhaps *your* product, too, can be improved with versatile Enjay Butyl. It comes in non-staining grades for white and light-colored parts, offers excellent electrical properties, low price and *immediate availability*. For full information, contact the Enjay Company. Complete laboratory facilities and technical assistance are at your service.

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How stop-and-go driving creates need for *low-duty* lube oil detergency

As you know, low-duty engine operation accounts for a large percentage of the average car owner's driving.

For 48% of American passenger car trips, for example, the average is less than 4 miles. For 75%, it is less than 10 miles. And more than 90% of all city bus, taxi and delivery truck operation is in stop-and-go city traffic.

Excessive build-ups of engine sludge are likely to result from these low-power, low-temperature operating conditions.

New-type detergents

After extensive research on this problem, Du Pont has developed two entirely new-type synthetic detergents . . . Lube Oil Additives 564 and 565.

Both are ashless *polymeric* additives that provide an economical and effective means of preventing engine oil sludge—particularly under low-duty, stop-and-go driving conditions.

V. I. improvers, too

Both of these additives do double duty as detergents and as V. I. improvers. The chief difference between these two polymeric additives is their molecular weight . . . providing refiners a choice, depending on the amount of V. I. improvement and shear stability that are required.

More efficient operation

These additives keep the engine oil system operating more efficiently. Oil screens, rings, pistons, filters and other engine parts are kept clean and free from sludge. The resulting free flow of oil throughout the engine keeps it in better condition for longer periods.

For more detailed information on how these new-type additives can improve automotive performance, call any of our sales offices listed below for a copy of "Du Pont Lube Oil Additives."

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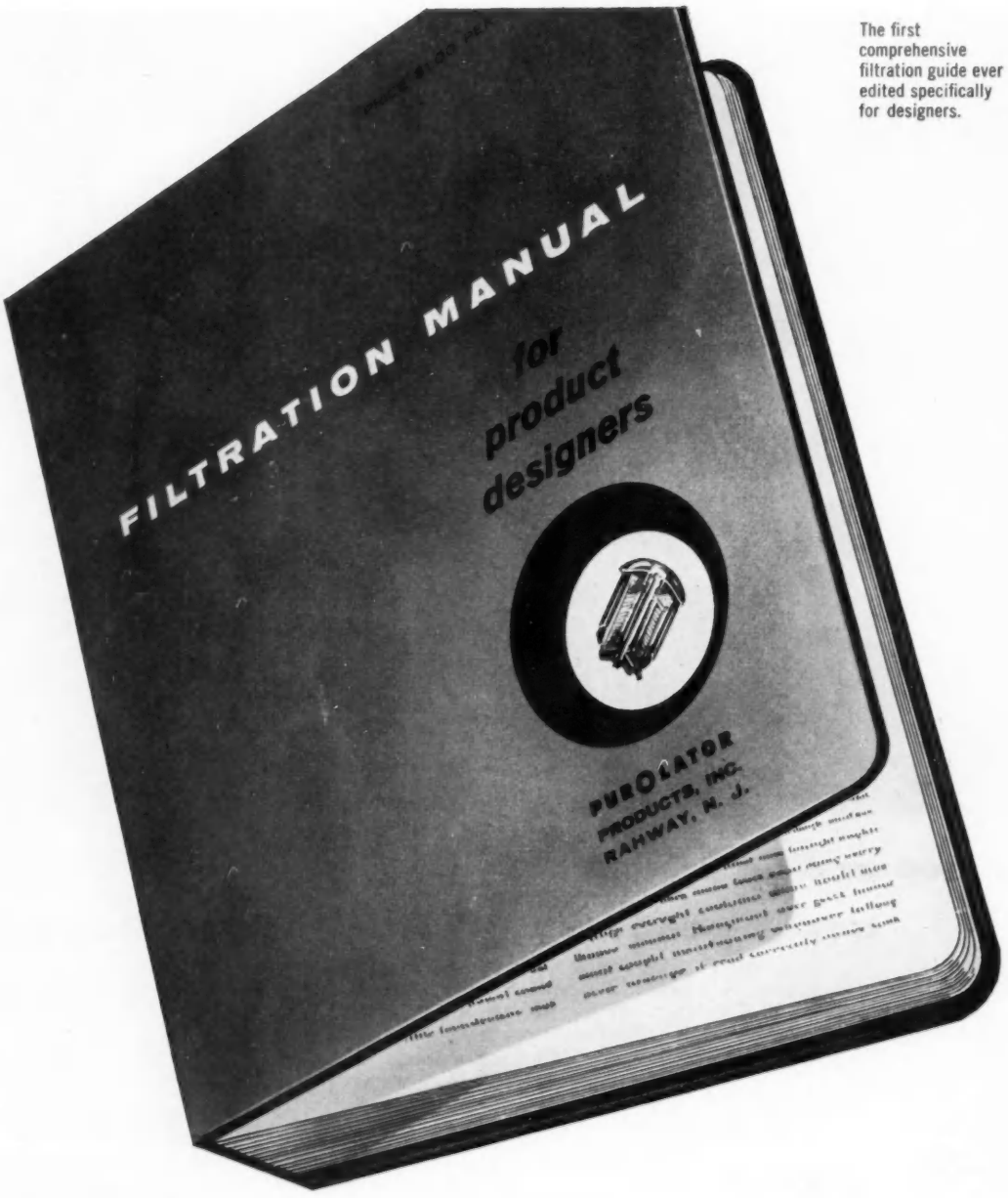

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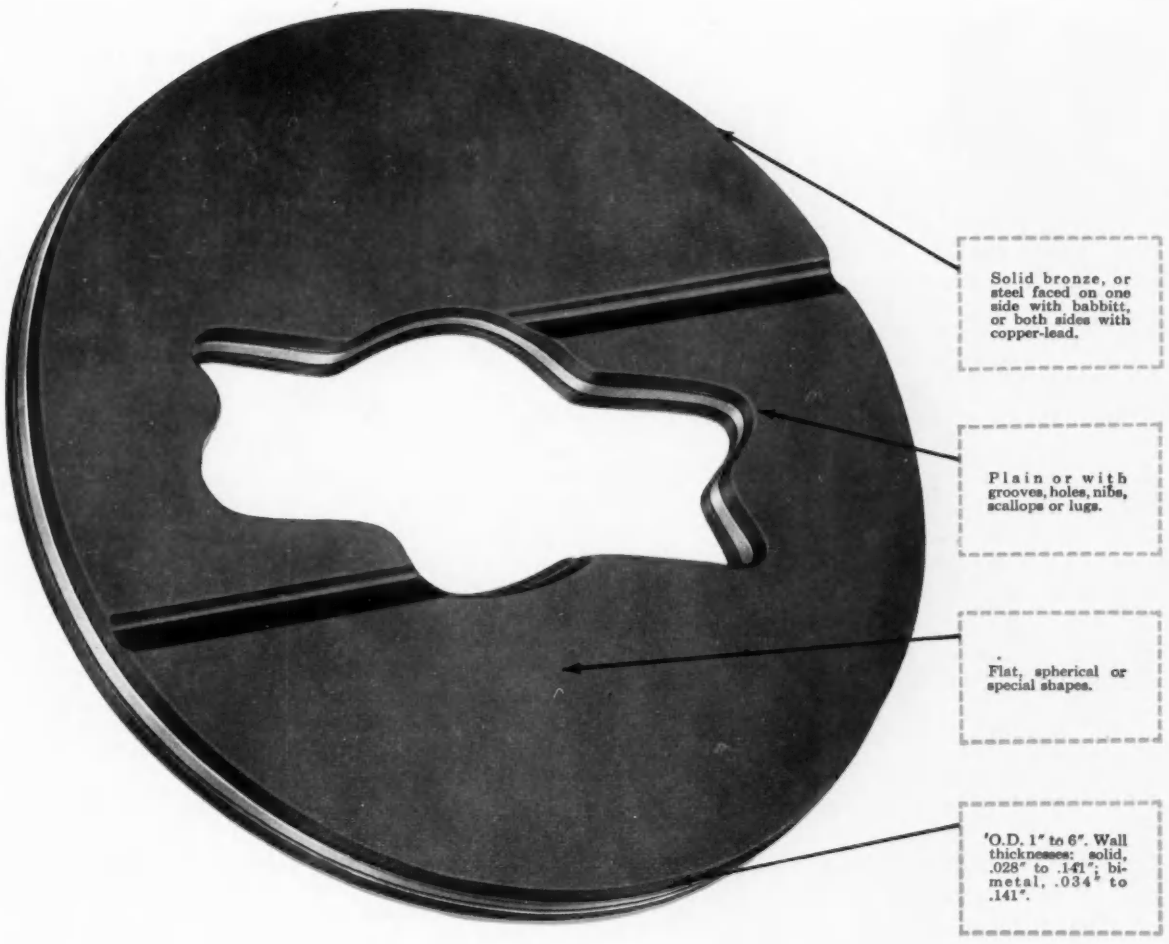
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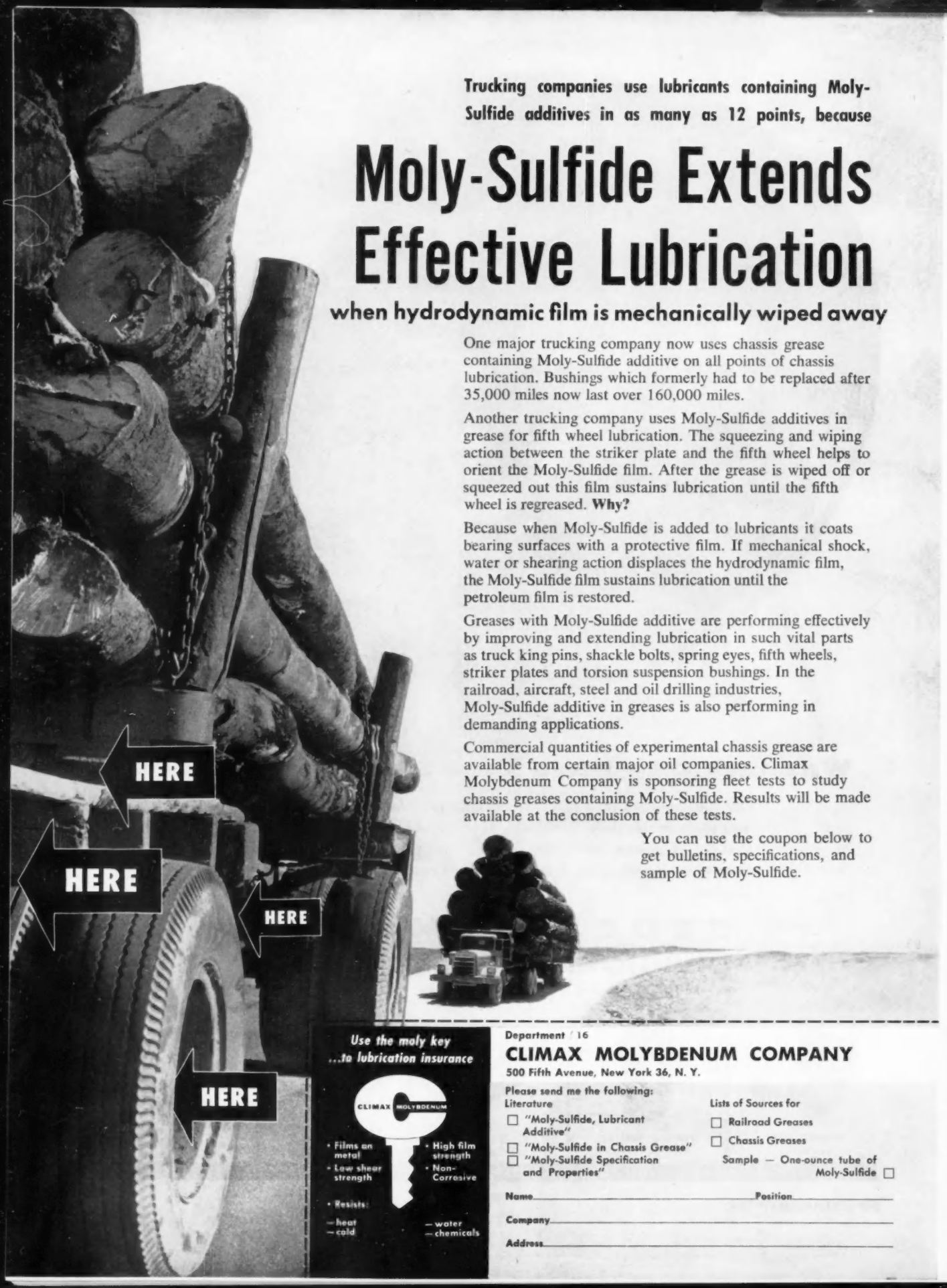

Trucking companies use lubricants containing Moly-Sulfide additives in as many as 12 points, because

Moly-Sulfide Extends Effective Lubrication

when hydrodynamic film is mechanically wiped away

One major trucking company now uses chassis grease containing Moly-Sulfide additive on all points of chassis lubrication. Bushings which formerly had to be replaced after 35,000 miles now last over 160,000 miles.

Another trucking company uses Moly-Sulfide additives in grease for fifth wheel lubrication. The squeezing and wiping action between the striker plate and the fifth wheel helps to orient the Moly-Sulfide film. After the grease is wiped off or squeezed out this film sustains lubrication until the fifth wheel is regreased. **Why?**

Because when Moly-Sulfide is added to lubricants it coats bearing surfaces with a protective film. If mechanical shock, water or shearing action displaces the hydrodynamic film, the Moly-Sulfide film sustains lubrication until the petroleum film is restored.

Greases with Moly-Sulfide additive are performing effectively by improving and extending lubrication in such vital parts as truck king pins, shackle bolts, spring eyes, fifth wheels, striker plates and torsion suspension bushings. In the railroad, aircraft, steel and oil drilling industries, Moly-Sulfide additive in greases is also performing in demanding applications.

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Years ago, periodic replacement of timing chains was expected by every auto owner. Today, Morse Timing Chains, specified on 18 out of the 22 automobiles made in America, are expected to last for the life of the automobile.

Life expectancy of timing chains has increased, thanks to Morse's rigid quality controls, automatic precision assembly machines, and advanced inspection equipment.

Check first with Morse on timing chain problems. Find out, too, how well other Morse products can answer your needs in power transmission design and application.

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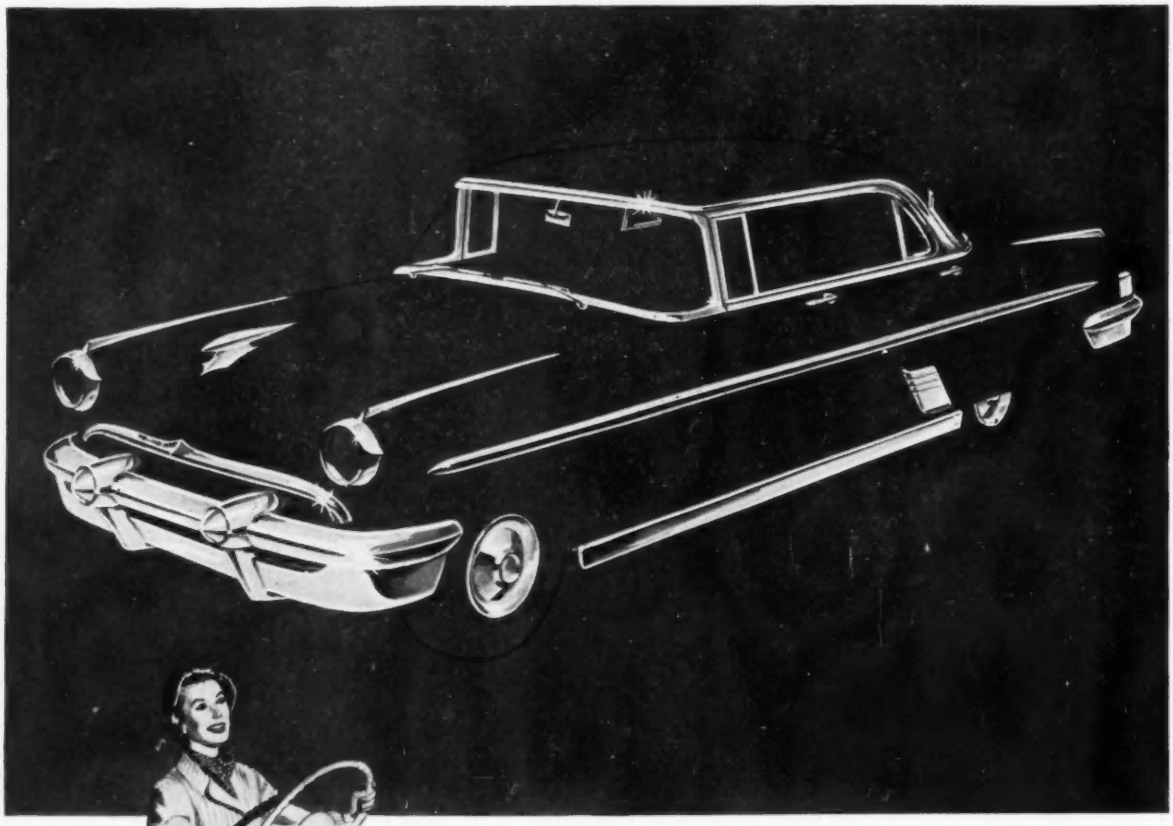

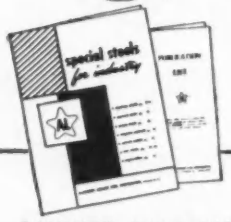

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Stainless steel brightwork (ask about it on the car *you* buy!) has much more than surface attractiveness. It has built-in, *timeless* beauty. Beauty that goes all the way through—doesn't scratch off or rust off. Beauty that lasts—outlives the car itself. And beauty that's practical . . . requires no weary polishing, just ordinary washing.

In fact, *wherever* it's used, AL Stainless delivers something extra in good looks, strength, service life and resistance to rust and wear. Even where its first cost is higher (and that's not always the case) stainless steel usually costs much less in the end, because it lasts so much longer than other materials.

AL Stainless Steel has given thousands of products a competitive edge: all sorts of products, from safety pins to railroad trains. Maybe there's a place in *your* business where it can boost sales appeal or reduce costs. Let's help you look. ***Allegheny Ludlum Steel Corporation, Oliver Building, Pittsburgh 22, Pa.***

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Propeller Shafts and
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The only propeller shaft with a 32 TOOTH CONVENTIONAL SPLINE SHAFT!

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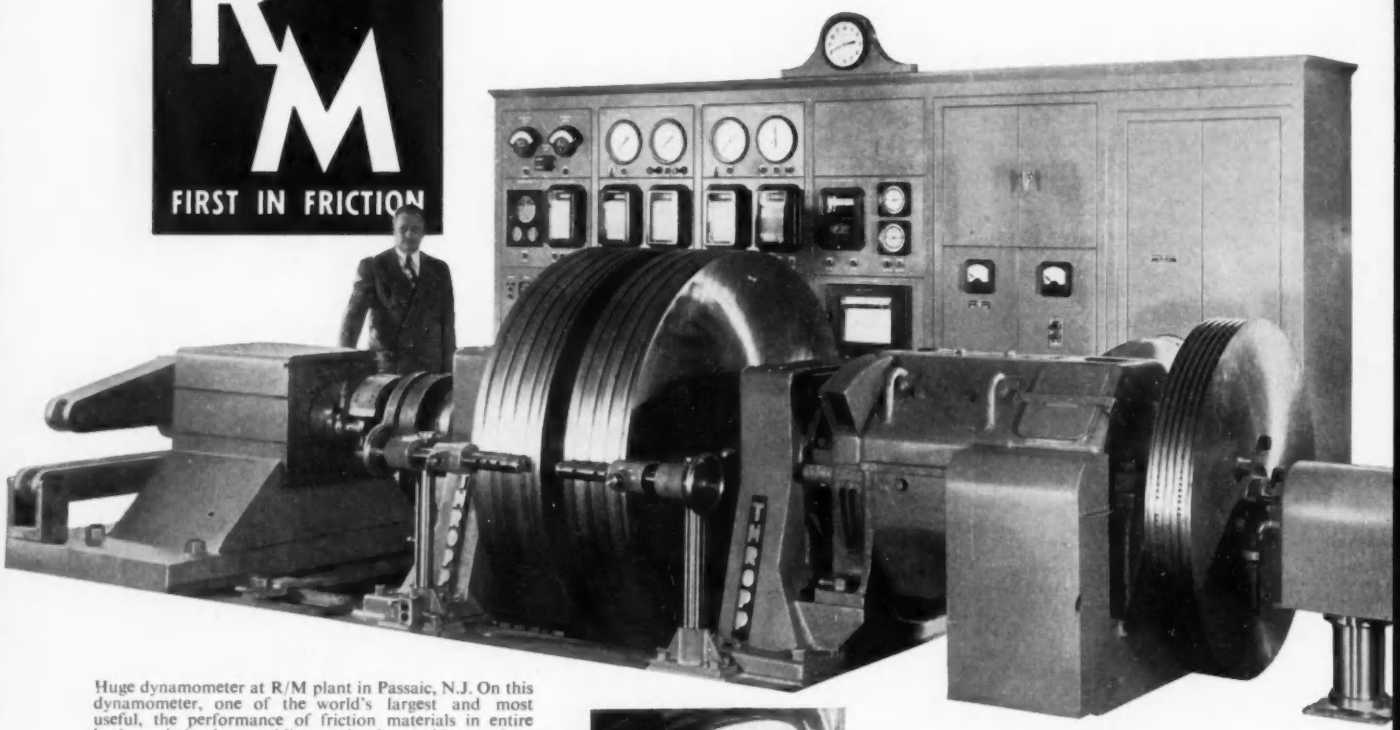
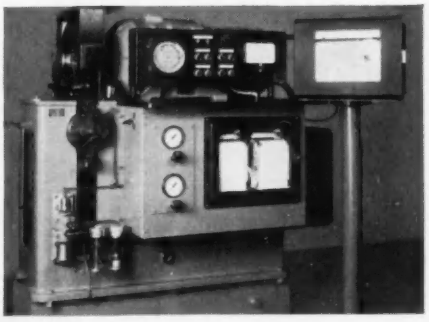
HOW R/M ENGINEERING SETS

R/M
FIRST IN FRICTION



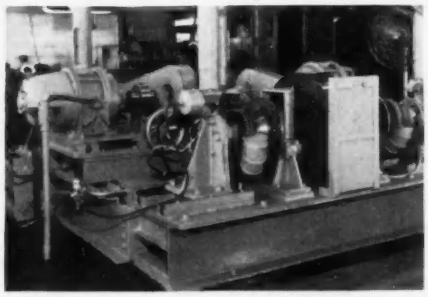
Huge dynamometer at R/M plant in Passaic, N.J. On this dynamometer, one of the world's largest and most useful, the performance of friction materials in entire brake and clutch assemblies can be thoroughly tested.

Cab of one of the special R/M trucks used in road testing brake linings and clutch facings.



R/M testing machine at plant in Passaic. On R/M dynamometers, a special Uni-Tork valve, invented by R/M and since adopted by the S.A.E., subjects brakes to a uniform rate of deceleration by continuously and automatically varying pressure to compensate for natural changes in frictional characteristics of material being tested. This valve helps produce test data much more closely related to actual field operating conditions than possible heretofore.

R/M maintains a permanent testing station near Jennerstown, Pa., along U.S. Route 30, considered to be the most severe mountain course of its kind in the U.S.A.



Duplex dynamometer at R/M plant in Bridgeport, Conn., used to run passenger car and other light duty brake tests. Four tests can be conducted simultaneously.

THE RECORD OF "FIRSTS" IN FRICTION MATERIAL DEVELOPMENT SHOWS WHY R/M IS FIRST IN FRICTION

FIRST Woven Brake Lining • FIRST Asbestos Brake Lining • FIRST Ground Wearing Surface • FIRST Zinc Alloy Wire Brake Lining • FIRST Pre-Treated Yarns • FIRST Extruded Pulp Brake Lining • FIRST Flexible Pulp Brake Lining in Rolls • FIRST Dry Process Brake Lining • FIRST Semi-Metallic Brake Lining • FIRST Bonded-to-Metal Brake Lining • FIRST Woven Clutch Facings • FIRST Molded Asbestos Clutch Facings for Clutches Operating in Oil FIRST Endless Woven Clutch Facings • FIRST Pre-Treated Clutch Facings • FIRST Bonded-to-Metal Clutch Facings

THE PACE IN FRICTION MATERIAL DEVELOPMENT

THE WORLD'S MOST COMPLETE

TESTING

ASSURES CUSTOMER SATISFACTION

Friction is an elusive phenomenon. To predict and control the performance of friction materials in new applications or combinations—particularly with today's precise operating requirements—is almost impossible except by actual proving on a vehicle or on a dynamometer.

That's why Raybestos-Manhattan, for over 50 years the world's largest maker of friction materials, has the world's most complete, most adaptable facilities for testing friction materials—both in the laboratory and on the highway.

Much of this test equipment was actually designed by Raybestos-Manhattan. In 1938, for example, R/M developed the first dynamometer ever made for the specific purpose of testing friction materials operating in oil.

R/M was the first to chart the properties of friction material operating in oil at speeds up to 18,000 rpm.

R/M dynamometers range from comparatively simple machines to giant inertia dynamometers—including one of the world's largest—on which customers' complete brake and clutch parts can be tested so as to bring out inherent design factors, such as servo, wrapping, distortion, and expansion due to heat.

There are certain factors—character of engagement, for example—that cannot be accurately evaluated in the laboratory. R/M therefore maintains its own vehicles for road testing brake linings, clutch facings and other friction parts under actual operating conditions—and on both level and high mountain country. At the well-known Jennerstown Mountain Testing Area, R/M maintains a year-round testing station where friction parts can be subjected to rigid tests under the most rigorous driving conditions . . . on grades up to 15%.

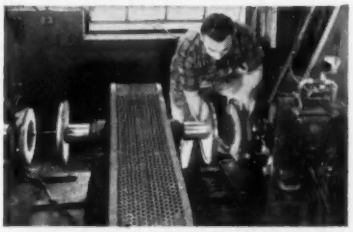
WHAT DOES THIS R/M TESTING MEAN TO THE O.E.M.?

It means, first, that friction material performance in full size brake and clutch assemblies of trucks, airplanes, buses, trains, off-highway equipment, and passenger cars may be thoroughly and accurately explored for you by R/M engineers.

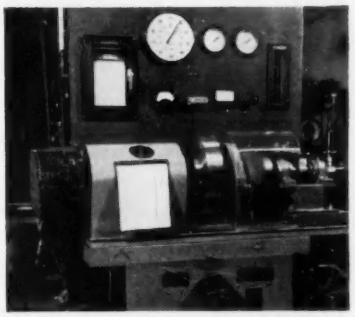
It means, second, that R/M has acquired knowledge of the behavior of friction materials under a wide range of operating conditions that provides exact answers to problems you may be facing now.

Unlike most other manufacturers, Raybestos-Manhattan works with all kinds of friction materials—from woven and molded asbestos to cork-cellulose and sintered metal. Consequently you are assured of the *best and most unbiased advice* on friction materials when you call in an R/M engineer.

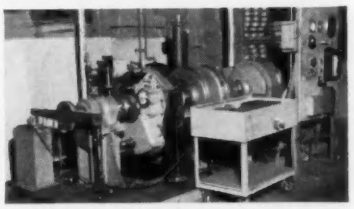
If you are working with friction materials —and wish to make that work more productive and more profitable—consult with an R/M representative. All of R/M's experience in friction and the complete facilities of its seven plants—with their research and testing laboratories—are as near as your telephone.



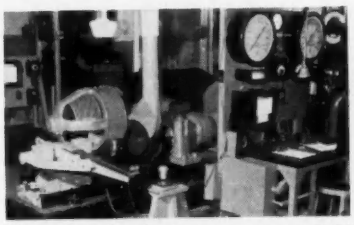
Friction material fade and wear characteristics are tested on this Long clutch machine at R/M plant in Manheim, Pa. Two clutch tests can be performed simultaneously here.



Transmission dynamometer at Bridgeport developed by R/M for complete testing of automatic transmission plates.



Heavy duty master wet clutch dynamometer at R/M plant in Crawfordsville. This dynamometer was built to test plates for the master clutch of a heavy-duty tractor. Speed and torque can be varied to match all service conditions a tractor will encounter.



Heavy-duty inertia dynamometer at R/M plant in Bridgeport used for special testing. Aircraft landing and take-off conditions, for example, can be approximated on this machine—with brake temperatures rising from 0° to 1500°F in 6 seconds.

Write for your free copy of R/M Bulletin No. 500. Its 44 pages are loaded with practical design and engineering data on all R/M friction materials.

R/M

FIRST IN FRICTION

THE TRADE-MARK THAT SPELLS PROGRESS IN FRICTION MATERIAL DEVELOPMENT

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EQUIPMENT SALES DIVISION: 6010 Northwest Highway, Chicago 31, Ill.
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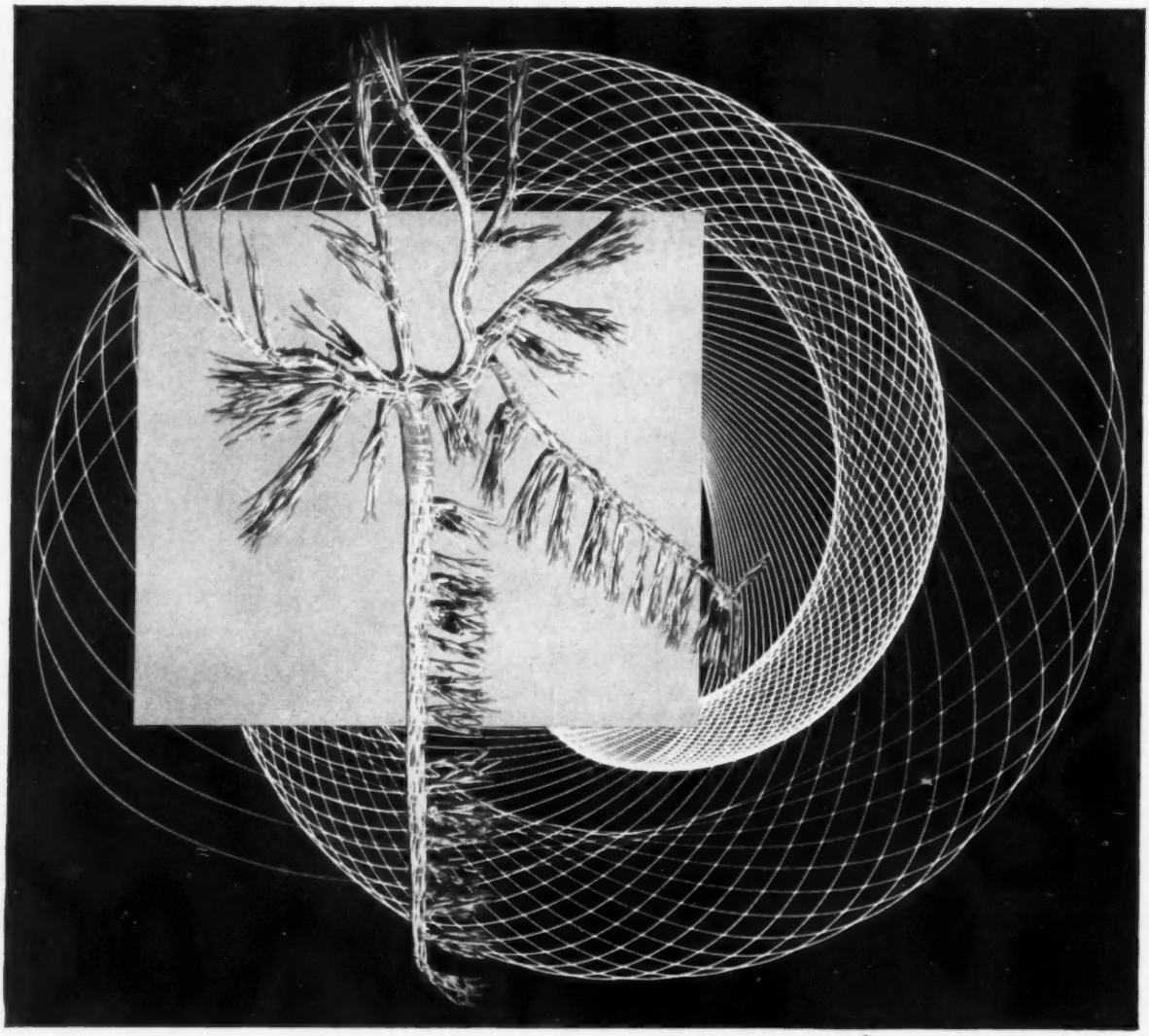
FACTORIES: Bridgeport, Conn.; Manheim, Pa.; Passaic, N.J.; No. Charleston, S.C.; Crawfordsville, Ind.; Neenah, Wis.; Canadian Raybestos Co. Ltd., Peterborough, Ont.

RAYBESTOS-MANHATTAN, INC., Brake Linings • Brake Blocks • Clutch Facings • Fan Belts • Radiator Hose
Industrial Rubber, Engineered Plastic, and Sintered Metal Products • Rubber Covered Equipment
Asbestos Textiles • Laundry Pads and Covers • Packings • Abrasive and Diamond Wheels • Bowling Balls



$$\bar{R}\,(T+t) = \bar{R}\,(t) + \dot{\bar{R}}\,(t)T + \ddot{\bar{R}}\,(t)\frac{T^2}{2} + \cdots$$

$$\tilde{=} \bar{R}\,(t) + \int_{-\infty}^{t} \bar{\bar{\omega}}\,(\tau) \cdot \bar{R}\,(t-\tau)\,d\tau$$

The vector equation above is basic to the development of armament controls for high-speed aircraft. A solution to this equation determines predicted target positions. Allied with this solution is the problem of optimum filtering of input data to assure the best overall system performance.

For 10 years, engineers at AUTONETICS, a Division of North American Aviation, Inc., have been dealing with fire control target prediction problems, and have developed unique and practical approaches to their solution. The AUTONETICS-designed and built MG-4 Fire Control System, installed in the NATO countries' F-86K SABRE JETS, represents hardware in actual use.

As a professional, you will be interested to know that AUTONETICS has complete facilities for the research, design, development, flight test and manufacture of integrated fire control weapons systems... as well as autopilots, inertial guidance systems, computers and special products. For more detailed information or employment, please write: AUTONETICS, Department SAE-N2, 12214 Lakewood Boulevard, Downey, California.

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A DIVISION OF NORTH AMERICAN AVIATION, INC.

THROUGH 6
STAGE DRAW...

No Damage

TO

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SURFACES!

Hunter Douglas Pre-Painted Aluminum Strip Forms Readily, Eliminates Painting and Finishing Costs!

Now available in a complete color range!

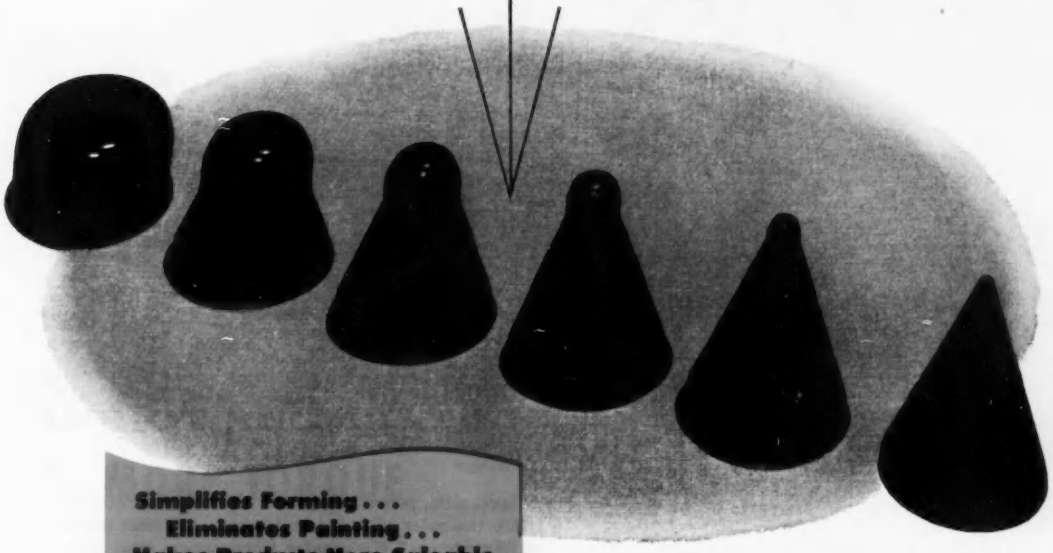
Here's visual testimony to the unusual elasticity of the painted surface on Hunter Douglas Pre-Painted Aluminum Strip! The cone illustrated was deep-drawn through six successive stages on a transfer press. Even though these dies were not specifically made for forming aluminum, and were experimentally applied, the deep draw was highly successful. Not a single blemish occurs on the pre-painted .035" 61S type aluminum stock!

This new Hunter Douglas achievement provides the metal forming industry with a better pre-painted strip which can be readily *roll formed, embossed, stamped* or *deep-drawn* without damage to the surface!

TWO COAT ENAMEL FINISH gives a hard, lustrous surface. Can be secured in a wide range of colors to harmonize or contrast with other decor. The double coating, with each coat individually baked, possesses remarkable adhesion and scratch resistance.

EXTERIOR DURABILITY COMPARABLE TO AUTOMOBILE FINISHES. This strip can be used for exterior purposes as well as for general commodities. Finishes are unusually color fast in sunlight, resistant to heat and cold and successfully pass 500 hour, 90°, 20° salt spray test without lifting or blistering.

STOCK SPECIFICATIONS. Mill quantities available in several aluminum alloys and tempers up to 8" wide, maximum; nominal thicknesses.



Simplifies Forming . . .
Eliminates Painting . . .
Makes Products More Saleable

. . . why not investigate the possibilities of Hunter Douglas *Pre-Painted* Aluminum Strip *now!*

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Hunter Douglas Aluminum Corporation

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For Ball Bearings
THE TREND IS TO SKF®

Sleek, slim, powerful, quiet... *Mercury Outboards* are the ruler of speed and spray – "Master of the Waterways." Kiekhaefer Corporation, who makes them, was first to feature extensive use of anti-friction bearings in outboards. And Kiekhaefer is another concern that purchases single row, deep groove ball bearings from SKF.

It's a trend... brought about because those whose business is to buy bearings recognize the improvements SKF has achieved in ball bearings – improvements in quiet running, improvements in sealing, improvements in bearing life. Maybe *you* too should switch to SKF Ball Bearings.

SKF INDUSTRIES, INC., PHILADELPHIA 32, PA.

2709

SKF

has them all

Ball Bearings ◯ Cylindrical Roller Bearings ▭
Spherical Roller Bearings ▭ Tyson Tapered Roller Bearings ▭

ROCKFORD

FIRST

Using a new type friction material of recent development, ROCKFORD was the FIRST to engineer these new materials into MORLIFE Clutches and Clutch Plates. They reduce clutch size and engaging pressure, operate longer without adjustment or plate replacement — and avoid down-time caused by burned or warped plates in heavy duty tractors, trucks, tanks, cranes, power units, shovels, bulldozers, earth movers and other heavy duty machines.

MORLIFE* CLUTCHES and CLUTCH PLATES

*TRADE MARK

"MORLIFE clutch has gone 851 hours without slipping or adjustment."

"MORLIFE clutches last 950 hours longer, without adjustment."

"MORLIFE clutch needs adjustment once a month, instead of daily."

"MORLIFE requires lighter handle pull and one tenth the adjustments."

"MORLIFE clutch going strong after 1695 hours, working in sand."

"MORLIFE pulls harder and lasts six to ten times longer."

400% MORE LIFE

100% MORE TORQUE

50% MORE HEAT RESISTANCE

Before you approve specifications for your next models, it will pay you to investigate how MORLIFE Clutches will add to the service life of your product and reduce the number of stops for adjustments and repairs. It also will pay you to recheck specifications for your present models. For information covering operating characteristics, write Department E.

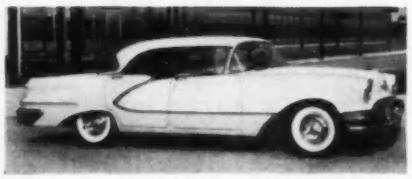
ROCKFORD Clutch Division BORG-WARNER

316 Catherine Street, Rockford, Illinois, U.S.A.

CLUTCHES

Fit for a King... Trimmed in stunning

STAINLESS



Glamorous Stainless moldings sweep the length and breadth of this modern sedan, adding new luxury and beauty.

Stainless' Corrosion resistance makes body interior and exterior trim easy to clean and keep clean.

Here's sculptured beauty at its best, heightened and preserved with stainless steel, used consistently on America's finest automobiles. For molding and trim—inside and out—in styling and detail, no other metal can match the deep beauty of stainless' durability, strength and corrosion resistance.

For designers and engineers, here's *the* modern metal to reduce weight, conserve space and make possible a simplified economical design. Stainless can be readily roll-formed, welded and machined—other important advantages.

Do not overlook stainless steel in your plans for a better-looking, better-engineered car. Your supplier has full particulars. Contact him today.

The finest stainless steels are made with Vancoram Ferro Alloys

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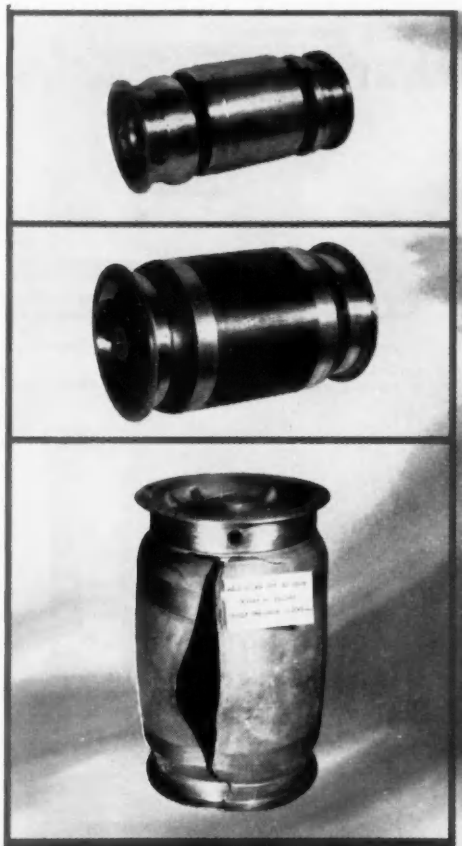


Top photo shows missile tank constructed of two forged and machined end caps and center section of tubing. Middle photo shows assembled tank. The *Uniwelds* are located in the approximate center of the bright machined bands. Bottom photo shows a tank that has been pressured to bursting with 2½ times normal operating pressure. Note that the split crosses both weld planes with no tendency to divert and follow the weld—graphic proof of 100% parent metal weld strength.

MISSILE TANKS *called for Pioneering, too!*

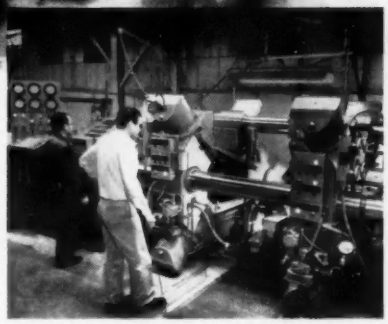
MENASCO UNIWELDS

PROVIDE FULL STRENGTH UTILIZATION IN HEAVY WALL PRESSURE VESSELS

Missile components, like the overall Missile System, have demanded that their designers and engineers pioneer with fresh thinking and new ideas in order to keep abreast of modern guided missile research and development. A case in point is MENASCO'S design and production of air tanks for the Nike missile featuring MENASCO'S now-famous *Uniweld* process, an exclusive method of pressure welding.

The twelve-inch diameter welds in the Nike tank fuse in two operations approximately 34 square inches of alloy steel. Because the *Uniweld* maintains parent metal strength, no increase in local wall thickness is needed and the tank becomes virtually a one-piece vessel.

Thus, MENASCO'S pioneering work in *Uniwelding* of missile tanks has opened entire new fields of pressure vessel applications where high strength welds make the difference.



One of MENASCO'S *Uniweld* machines in operation. This exclusive MENASCO process is gaining wide acceptance in the aircraft and missile fields.

Specialists in Aircraft Landing Gear

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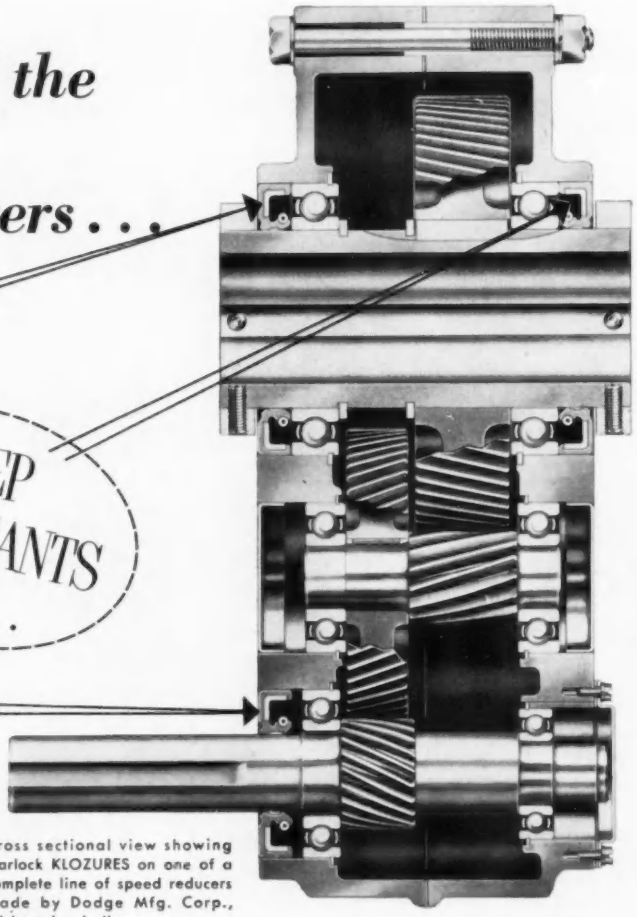
Over *half* the speed reducer manufacturers . . .

KEEP DIRT OUT . . .

KEEP LUBRICANTS IN . . .

WITH KLOZURE* Oil Seals



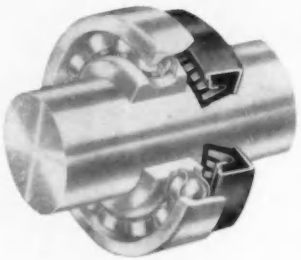
Cross sectional view showing Garlock KLOZURES on one of a complete line of speed reducers made by Dodge Mfg. Corp., Mishawaka, Indiana.

Makers of such fine precision products as The Dodge Torque-Arm Speed Reducer will not compromise when specifying oil seals. They know that the reputation of their entire product may depend on the quality of the oil seals they put in it.

Think about this the next time you have occasion to specify oil seals, and we think you'll choose Garlock KLOZURE Oil Seals—guaranteed to do the job you specify with minimum power loss and heat generation.

KLOZURES are available in a complete range of types and sizes. Therefore, be sure to call in one of Garlock's 125 trained sales engineers right at the start. His experience will save you time and money. Or, write today for Catalog No. 10.

**Registered Trademark*



Model 53 finger spring KLOZURE for normal and high speed service, applied to a shaft to protect the ball bearing.

THE GARLOCK PACKING COMPANY, Palmyra, New York

For Prompt Service, contact one of the 30 sales offices and warehouses throughout the U. S. and Canada.

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Packings, Gaskets, Oil Seals, Mechanical Seals, Rubber Expansion Joints

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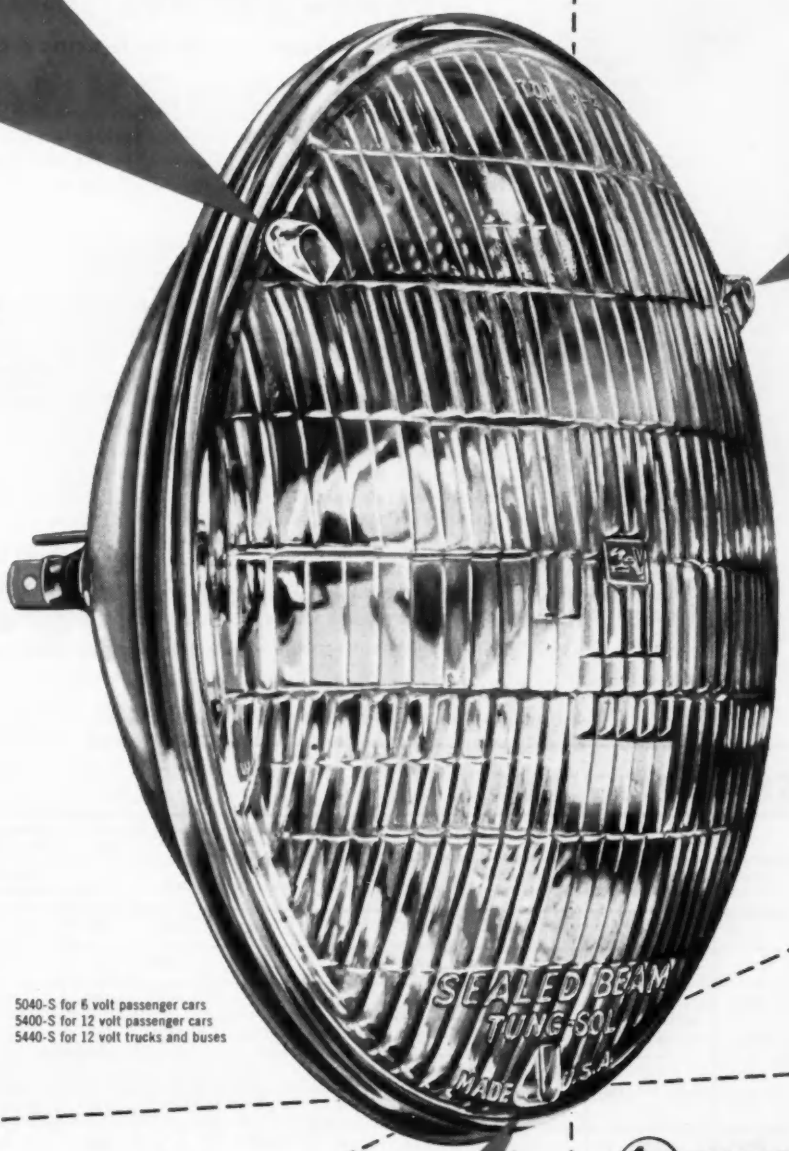

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E-Z AIM PLATFORMS

Precision-molded platforms for accurate beam adjustment with all approved aiming devices

5040-S for 6 volt passenger cars
5400-S for 12 volt passenger cars
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52 YEARS OF LEADERSHIP IN AUTOMOTIVE LIGHTING

TUNG-SOL ELECTRIC INC., NEWARK 4, N. J.

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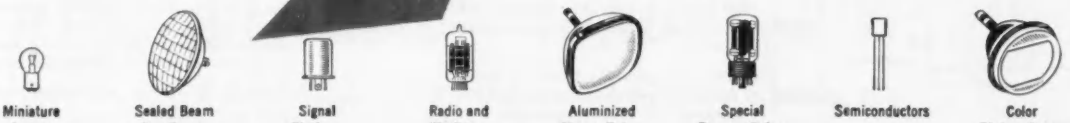
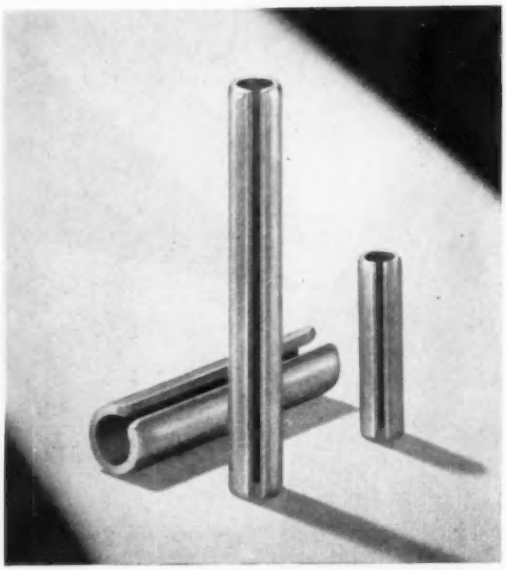


Miniature Lamps | Sealed Beam Headlamps | Signal Flashers | Radio and TV Tubes | Aluminized Picture Tubes | Special Purpose Tubes | Semiconductors | Color Picture Tubes

Eliminate Tapping, Peening, Milling with Sel-Lok Spring Pins



SEL-LOK spring pins are made of alloy steel, heat treated for uniform toughness and long-lasting spring action. Ends are tapered to make driving easy; edges of axial slot are rounded to prevent scoring of drilled holes.

Versatile self-locking fasteners reduce assembly, maintenance time

SEL-LOK spring pins materially reduce production costs, because you can install them in plain drilled holes with either hand or automatic assembly tools. They eliminate expensive close-tolerance tapping, reaming, peening and milling operations, and the associated rejects and waste.

Use **SEL-LOK** spring pins as axles, keys, hinge pins, cotter pins, pivot or stop pins. Use them to secure gears to shafts or to assemble universal joints or complex mechanical linkages. Once you've installed them, they stay put. They resist vibration and shock, because the hollow split tube flexes to absorb impact or shearing stresses. And you can remove them easily with a drift pin or punch. Since they spring back to original diameter when removed, they can be reused again and again without losing locking efficiency.

SEL-LOK spring pins are stocked by your authorized industrial distributor. See him for details. Or write us for Bulletin 2014 and samples, or for information about any problem you think these easy-to-use pins might solve for you. Sel-Lok Spring Pin Division, Standard Pressed Steel Co., Jenkintown 55, Pa.

SEL-LOK SPRING PIN DIVISION

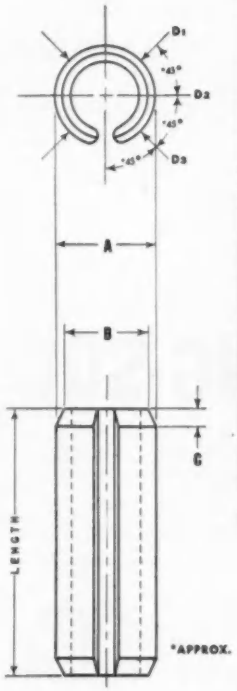
STANDARD PRESSED STEEL CO.

SPS

JENKINTOWN PENNSYLVANIA

SEL-LOK spring pins in standard sizes are available at your authorized distributor's. Consult SPS for special sizes, materials and finishes.

SPECIFICATIONS



A			B	C	WALL THICKNESS	RECOMMENDED HOLE SIZE		MIN. DOUBLE SHEAR STRENGTH IN POUNDS (STANDARD PIN CARBON STEEL)
NOMINAL PIN DIA.	MAXIMUM DIA. (GO RING GAGE)	MINIMUM DIA. 1/3 (D1+D2+D3)	MAX.	NOM.	S STANDARD	MIN.	MAX.	
.062	.069	.066	.059	.011	.012	.062	.065	425
.078	.086	.083	.075	.014	.018	.078	.081	650
.094	.103	.099	.091	.018	.022	.094	.097	1,000
.125	.135	.131	.122	.024	.028	.125	.129	2,100
.156	.167	.162	.151	.028	.032	.156	.160	3,000
.187	.199	.194	.182	.036	.042	.187	.192	4,400
.219	.232	.226	.214	.042	.050	.219	.224	5,700
.250	.264	.258	.245	.042	.050	.250	.256	7,700
.312	.328	.321	.306	.060	.062	.312	.318	11,500
.375	.392	.385	.368	.060	.077	.375	.382	17,600
.500	.521	.513	.485	.060	.094	.500	.510	25,800

MATERIALS Carbon steel and corrosion resistant steel.

SIZES Standard pins are available in sizes from .062 x 3/8" to .500 x 5".

FINISH Plain finish is standard. Pins are also available cadmium or zinc plated, or phosphate coated.

HARDNESS Carbon steel pins—Rockwell "C" 46-53 or equivalent; corrosion resistant steel pins—Rockwell "C" 43-52 or equivalent.

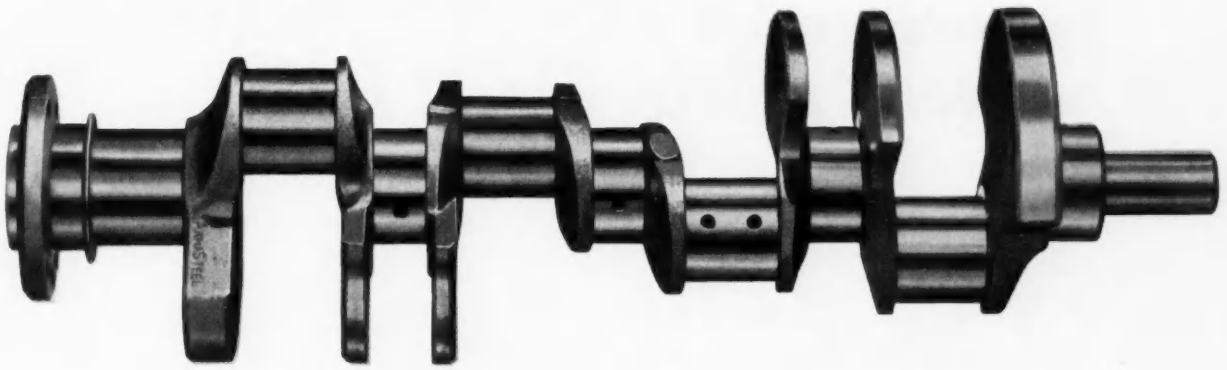
LENGTH TOLERANCES

0.250 to 1.000	± .015
1.001 to 2.000	± .020
2.001 to 3.000	± .025
3.001 to 4.000	± .030

STRENGTH The minimum shear strengths of standard carbon steel pins are listed above. All spring pins are heat treated to produce this shear strength as well as the spring characteristics.

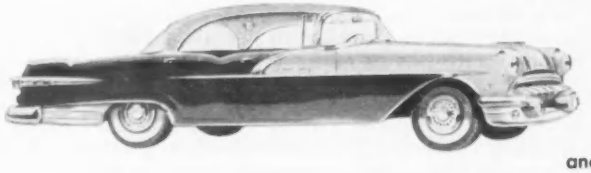
PRICES Ordering information and prices upon request.

WHY PONTIAC SWITCHED TO ARMASTEEL SHELL-CAST CRANKSHAFTS



For many years automotive engineers have sought to produce a successful cast crankshaft. But either the material or the method of casting did not give the desired results. Now, however, Central Foundry Division has solved both problems by means of their tough pearlitic malleable iron, ARMASTEEL, and their perfected shell molding process. Pontiac Motor Division is the first of the great automobile manufacturers to capitalize on the advantages of the new ARMASTEEL crankshafts. After conducting a long and exhaustive series of tests in the laboratory and on the road, Pontiac is now installing shell-cast ArmaSteel crankshafts in all 1956 models.

ARMASTEEL, the metal, is a triumph of modern metallurgy that combines the advantages of both castings and forgings. Its resistance to fatigue and wear assures long life. Its rigidity results in minimum deflection and accurate alignment. Its high damping capacity allows it to absorb vibrant energy and thus contribute to noiseless operation.



The crankshaft made by the shell-mold process at Central Foundry results in substantial manufacturing savings. Because the castings are so close to the final finished dimensions, shell-cast ArmaSteel crankshafts are lighter and require considerably less machining and finishing. Shell molding also gives the engineer considerably greater latitude in design.

Many manufactured products can be improved and the costs lowered with shell-cast ARMASTEEL. If you are a manufacturer, engineer, production man or purchasing director, it will pay you to write us today for your copy of the book "ARMASTEEL" and the pamphlet "Shell Molding at Central Foundry."

CENTRAL FOUNDRY DIVISION

GENERAL MOTORS CORPORATION

SAGINAW, MICHIGAN · DEPT. 18

65

Multi-Flex quiz for automotive engineers who want greater freedom of design

WHAT ARE U. S. MULTI-FLEX PRODUCTS?

They are accordion-like, tubular rubber products that have a versatility and an adaptability impossible to duplicate in connections made by conventional methods. Produced by United States Rubber Company, they are made of natural or synthetic rubbers—with or without cotton, asbestos, glass or nylon fabrics. With few exceptions, all U. S. Multi-Flex products are made to order for specific applications.

MULTI-FLEX PRODUCTS ARE CIRCUMFERENTIALLY CORRUGATED!

This gives flexibility, rigidity, and the ability to take movements in axial extension and compression. Other qualities are:
• Resistance to crushing and fatigue • Resistance to extremes of temperatures, abrasives, corrosives, oil, water, and grease • High travel ratio.

WHAT ARE SOME EXAMPLES OF MULTI-FLEX PRODUCTS?

Above are shown only six of the various styles of U.S. Multi-Flex boots. Because Multi-Flex boots are custom-made, THEY CAN BE "TAILORED" TO MEET THE EXTENSION, COMPRESSION AND DESIGN REQUIREMENTS OF ALMOST ANY APPLICATION.

WIDE APPLICATION FOR MULTI-FLEX!

In industry: Multi-Flex boots are used for rams in hydraulic presses making grinding wheels or other abrasive materials; on adjusting screws in grinders and machine tools; for guide rods in mechanical stamping presses; for reciprocating parts and for pistons and worm gears in a multitude of applications; for any hydraulic cylinders and other reciprocating parts requiring protection.

Automotive Engineers: there is probably an application for Multi-Flex in your design. Why not check with us today?

In Detroit, phone Trinity 4-3500 or write U. S. Rubber, Automotive Sales, New Center Bldg., Detroit 2, Michigan.

US RUBBER

Mechanical Goods Division

United States Rubber

Why nearly half of today's trucks use engine control systems by Holley

Maximum power at minimum cost. This is the reason more than half of America's major truck manufacturers — among them Ford, GMC, International Harvester and White — factory-equip their engines with control systems by Holley.

For over fifty years Holley has built carburetors, distributors and other engine components integrally designed to provide top performance at lowest operating cost. The now-widely-used 4-barrel carburetor with governor, for example, is one of a number of Holley engineering firsts originally designed, developed and manufactured by Holley for the trucking industry.

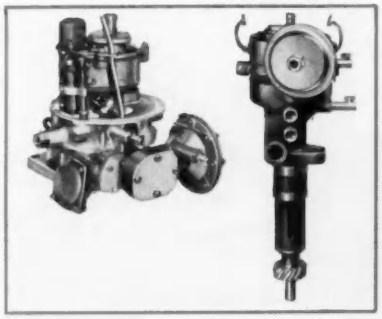
Truck, automobile and aircraft engine producers have proven that wherever engine control systems are needed—for main or auxiliary motors—Holley's half century of design, engineering and manufacturing experience sets the standard.

When your requirements call for maximum engine performance at minimum operating cost, specify Holley engine control systems. Many aircraft manufacturers; more than ten million automobiles; and over half of the nation's leading truck producers do.

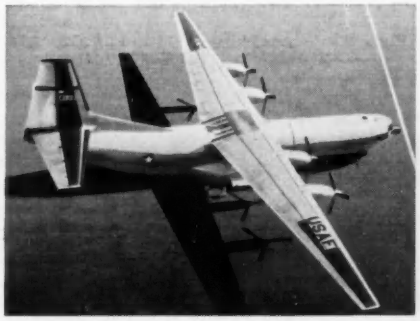
HOLLEY Carburetor Co.

11955 E. Nine Mile Road, Van Dyke, Michigan

For more than half-a-century—original equipment manufacturers for the automotive industry.



IN TRUCKS—manufacturers combine Holley's carburetor, distributor and governor for an integrally-designed control system providing maximum power and economy.



IN PLANES — specially-designed power control systems and other precision parts by Holley contribute greatly to safe flying by making many necessary engine adjustments automatically.

IN AUTOMOBILES—more than ten million of them now on the road are using carburetors, distributors, heat regulators designed by Holley for finest performance.

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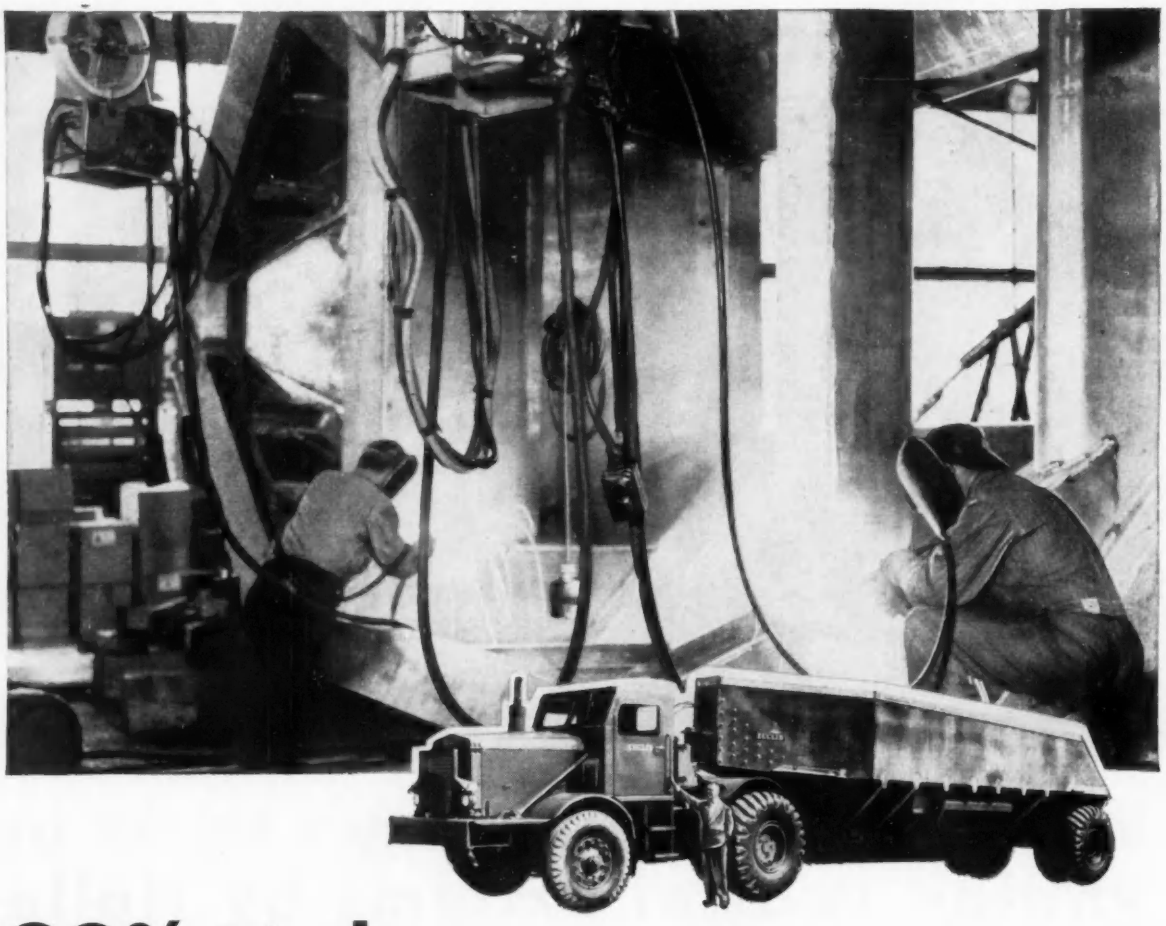

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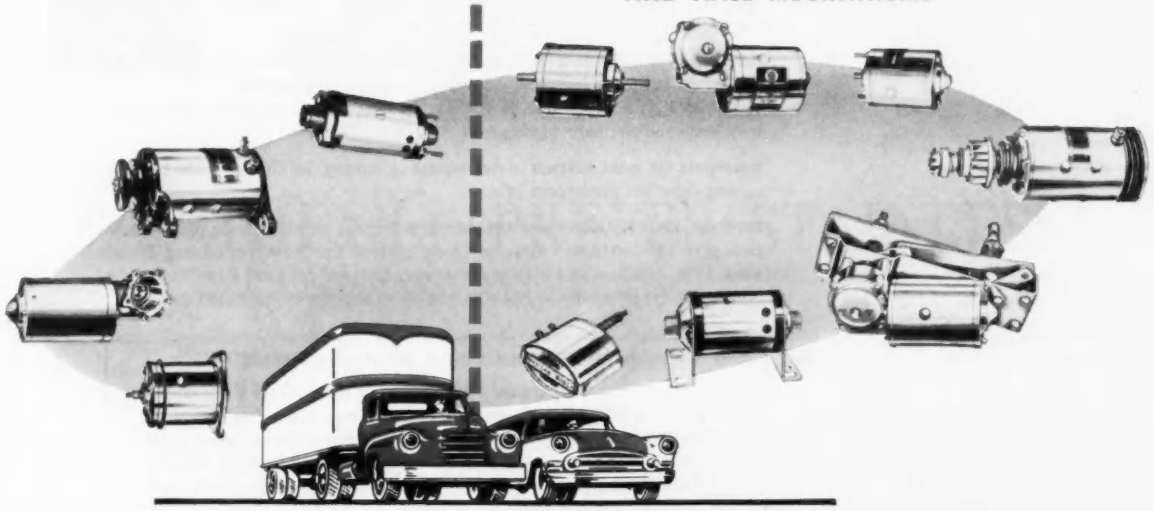

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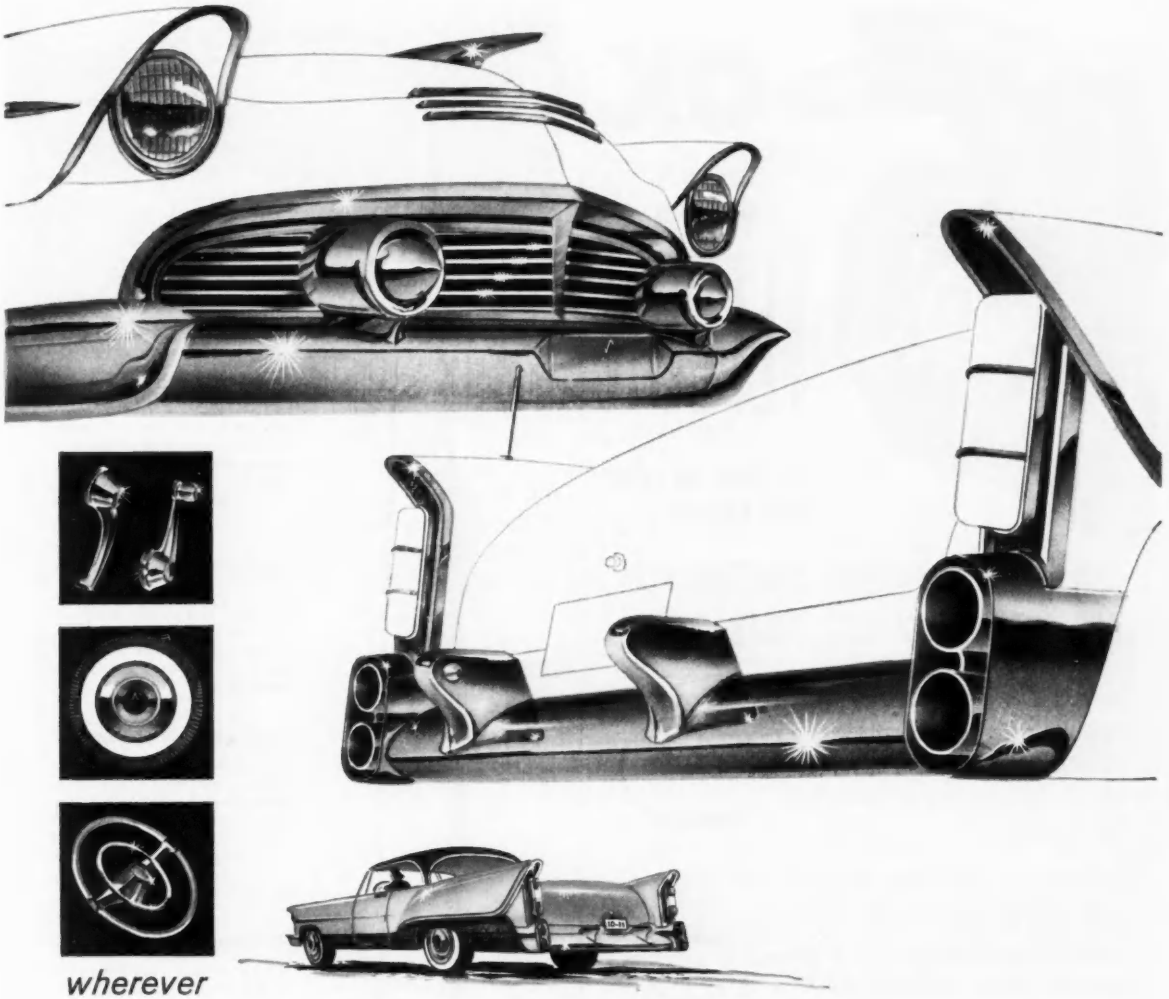

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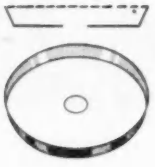

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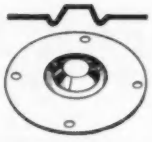

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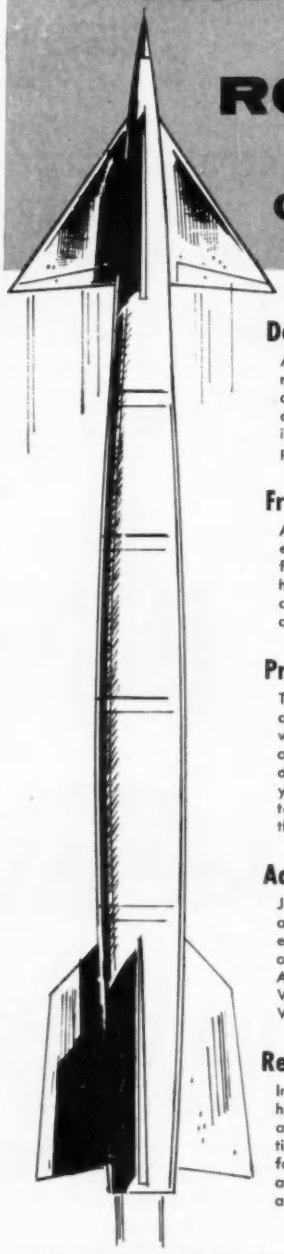

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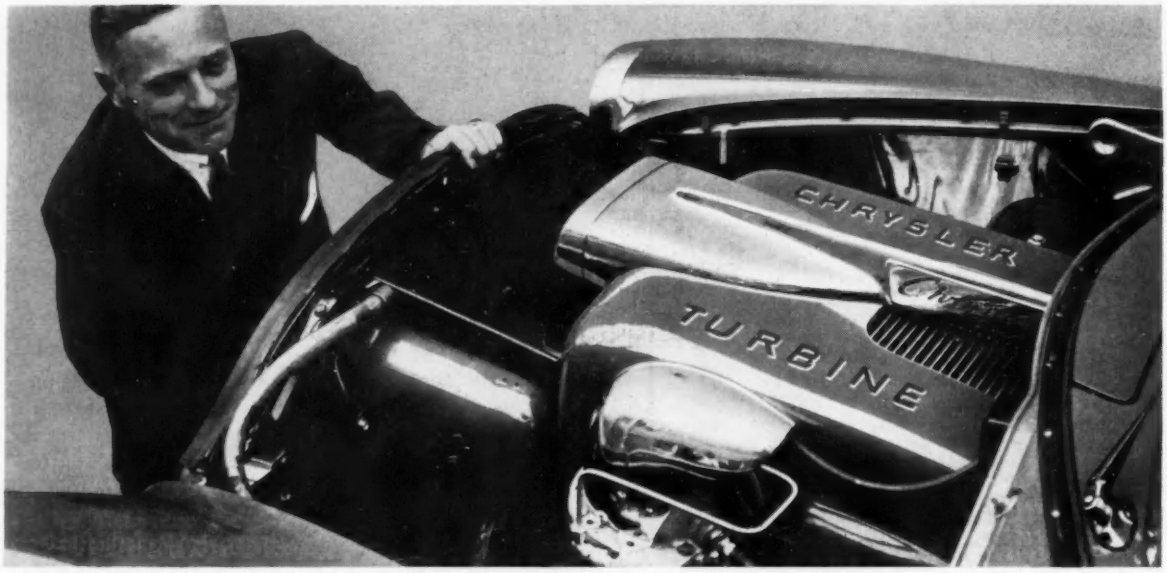

Mr. G. J. Huebner, Executive Engineer-Research, with the regenerative Chrysler Gas Turbine—the first gas turbine to successfully power an American production model passenger car.

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Here you see one of those "firsts"—Chrysler Corporation's regenerative gas turbine automobile. This raging twister, weighing nearly 200 pounds less than a piston engine of comparable power, easily fits a Plymouth's engine compartment. In this gas turbine two major problems long encountered in this field—high exhaust heat and high fuel consumption—have been overcome, and its performance is now comparable with the reciprocating engine.

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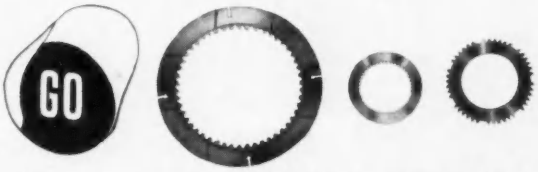

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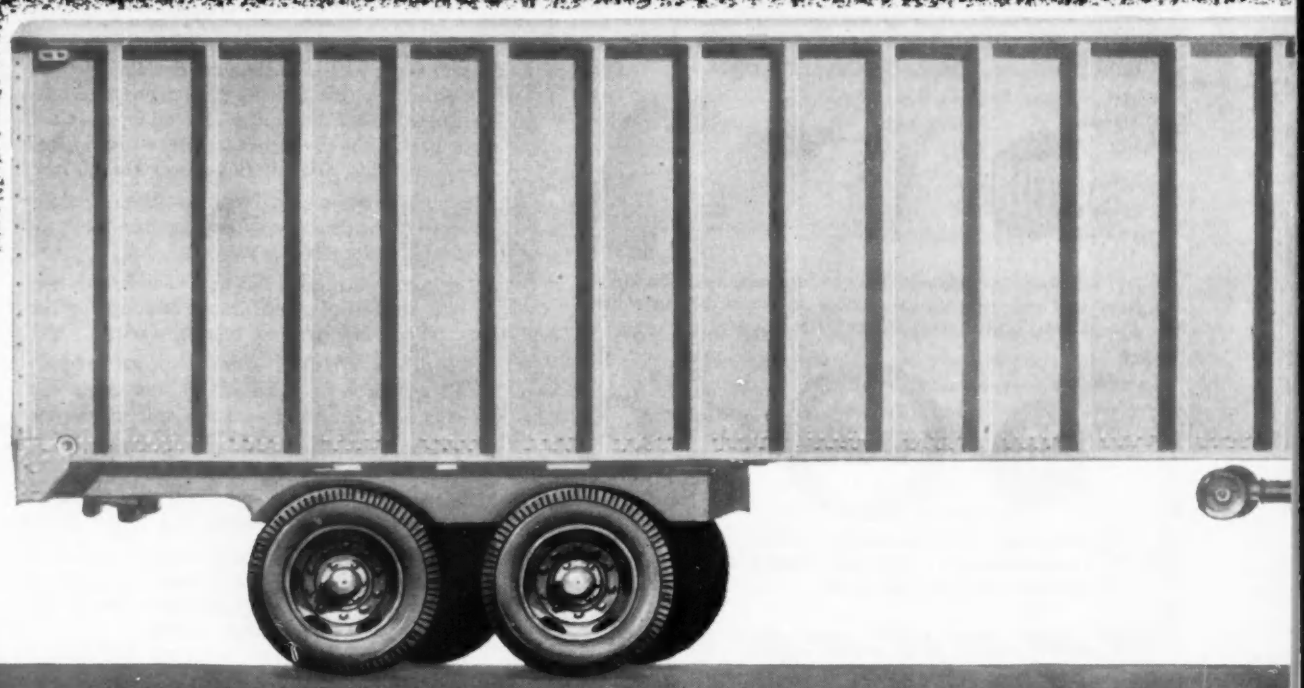

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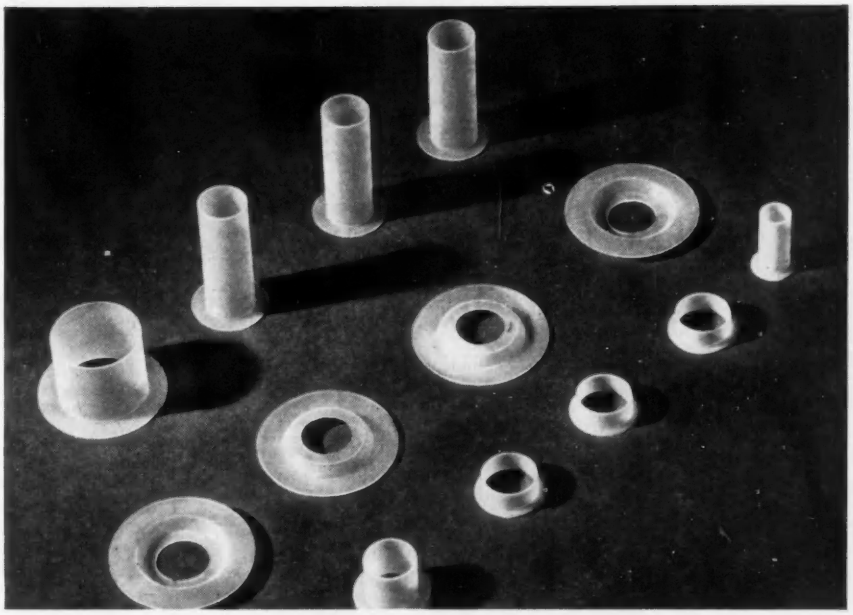
The physical properties of Du Pont "Zytel" nylon resin are particularly applicable to the field of automotive engineering. The strength, heat resistance, resilience and lightness in weight of "Zytel", coupled with its moldability, have already been put to use in many specific jobs.

"Zytel" as a bearing material is unique in that it can perform satisfactorily over a useful range of loads and operating conditions, with little or no lubrication. This characteristic is extremely valuable for bearings which must operate in hard-to-reach spots where lubrication is a problem. The resistance of "Zytel" to oils, gasoline and grease further expands its range of usefulness.

Of equal interest are the design possibilities that exist with *lubricated* bearings of "Zytel". Recent Du Pont laboratory tests revealed that simple sleeve bearings of "Zytel", under conditions of hydrodynamic lubrication, can support loads up to 1,000 psi at rubbing velocities up to 500 fpm with negligible wear. These tests also revealed that with "Zytel", hydrodynamic lubrication can be maintained with a minimum amount of lubricant present. In one case, with only an initial lubrication of a bearing, the bearing operated continuously for 41 days without increase in temperature or torque.



These brake-pedal bushings and window crank-handle bearing plates are made of "Zytel". The parts give smooth, quiet operation and provide long-wearing bearing surfaces which, after assembly, do not have to be lubricated for the life of the vehicle.

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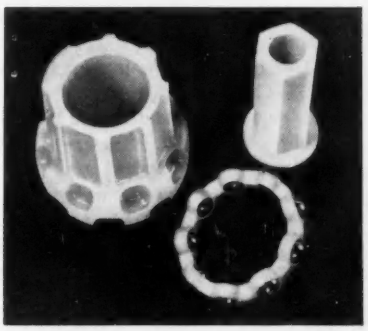

Representative bearings and bushings of lightweight "Zytel" nylon resin feature excellent abrasion resistance, toughness in thin sections, heat resistance and resiliency.

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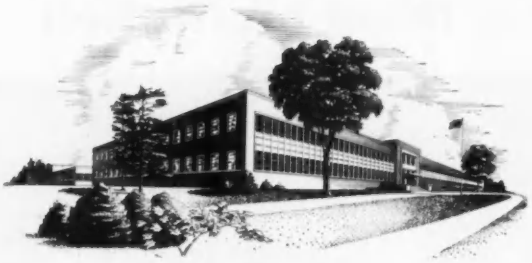

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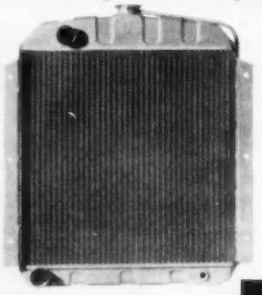

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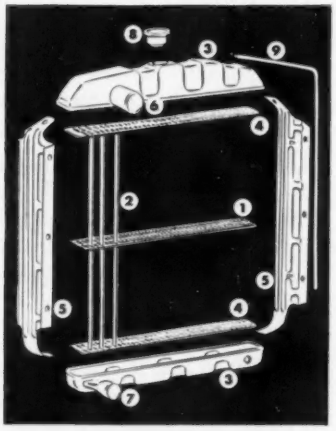

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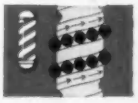
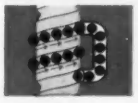


Nut *glides* on steel balls. Like stripes on a barber pole, the balls travel toward end of nut through spiral "tunnel" formed by concave threads in both screw and mating nut.



At end of trip, one or more tubular guides lead balls diagonally back across outside of nut to starting point, forming closed circuit through which balls recirculate.

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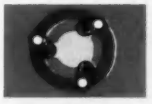
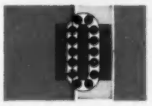


The *Saginaw b/b Spline* radically increases the efficiency of transmitting or restraining high torque loads. Instead of *sliding* against each other, the mating surfaces *glide* on rolling balls.



The steel balls recirculate in closed circuits formed by mating longitudinal raceways spaced around the circumference of both inner and outer splines. Guides return balls to starting point.

UP TO 5 TIMES MORE EFFICIENT

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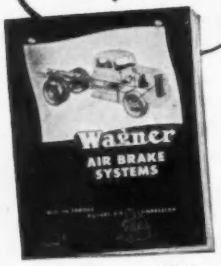

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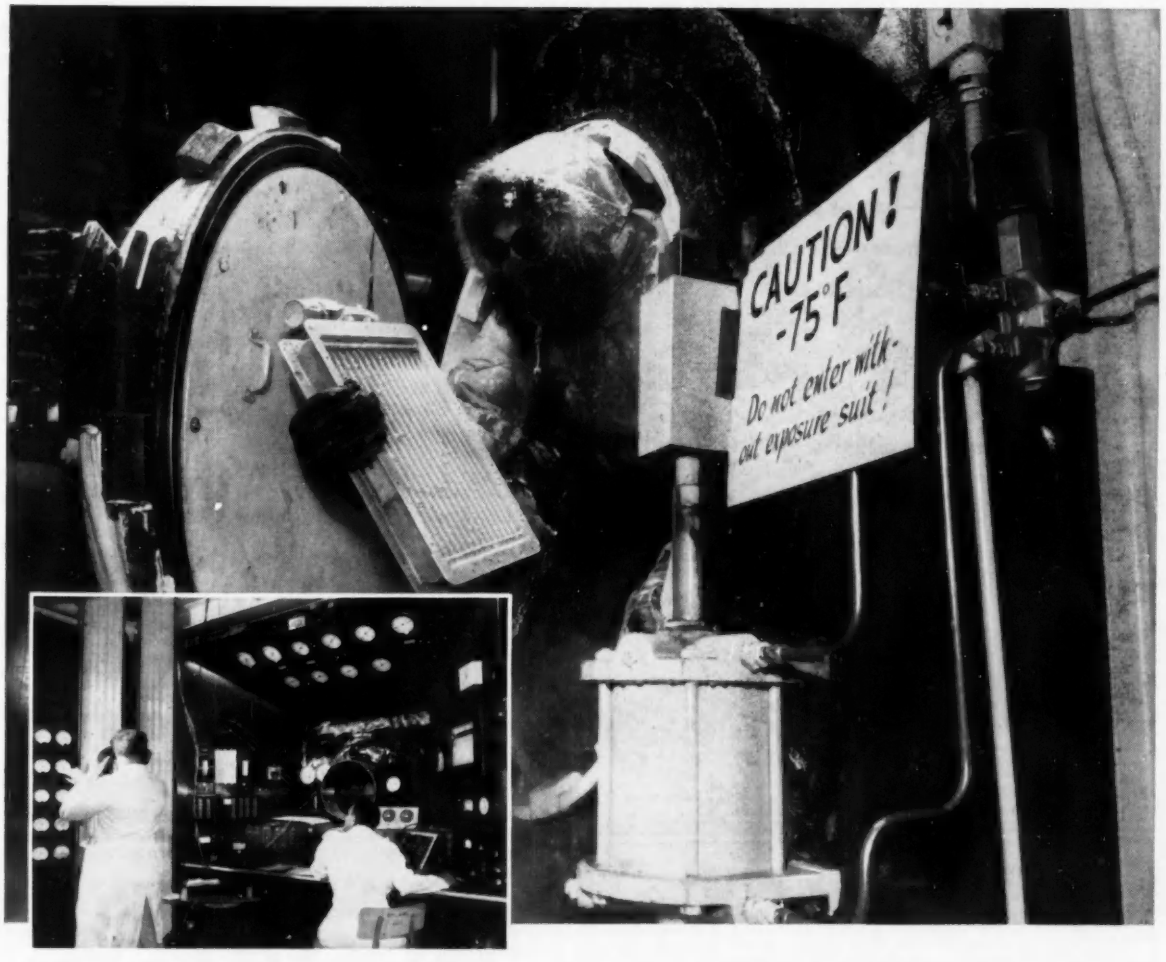

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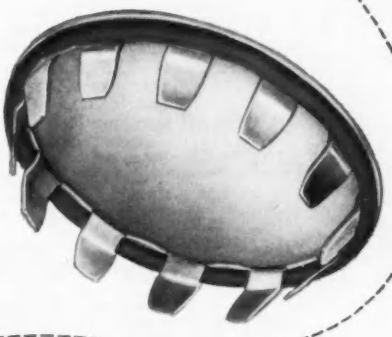

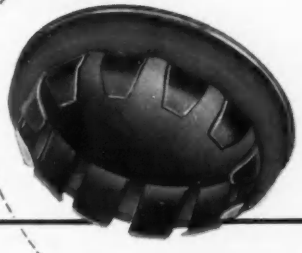

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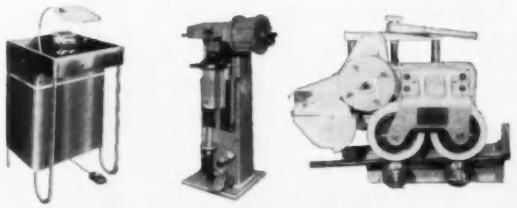

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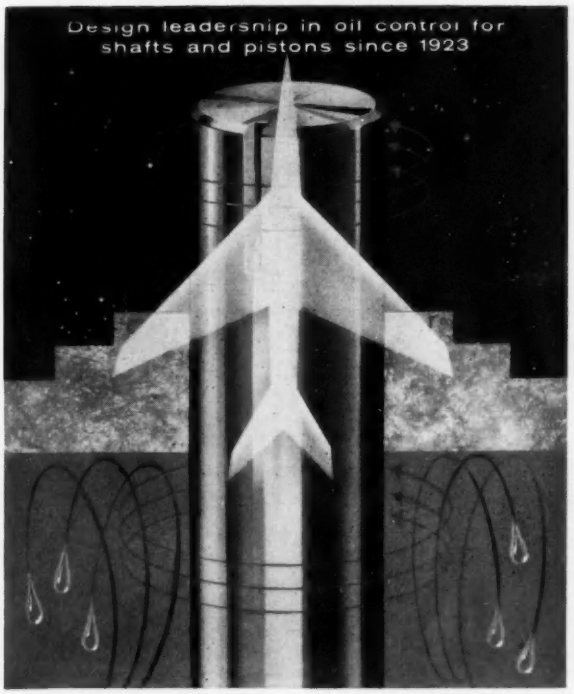

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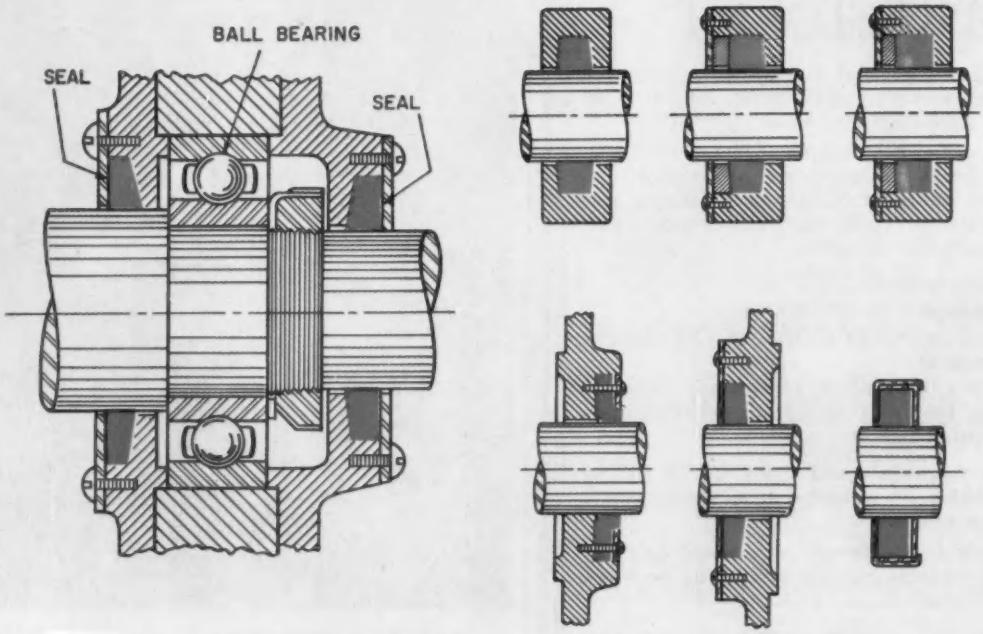

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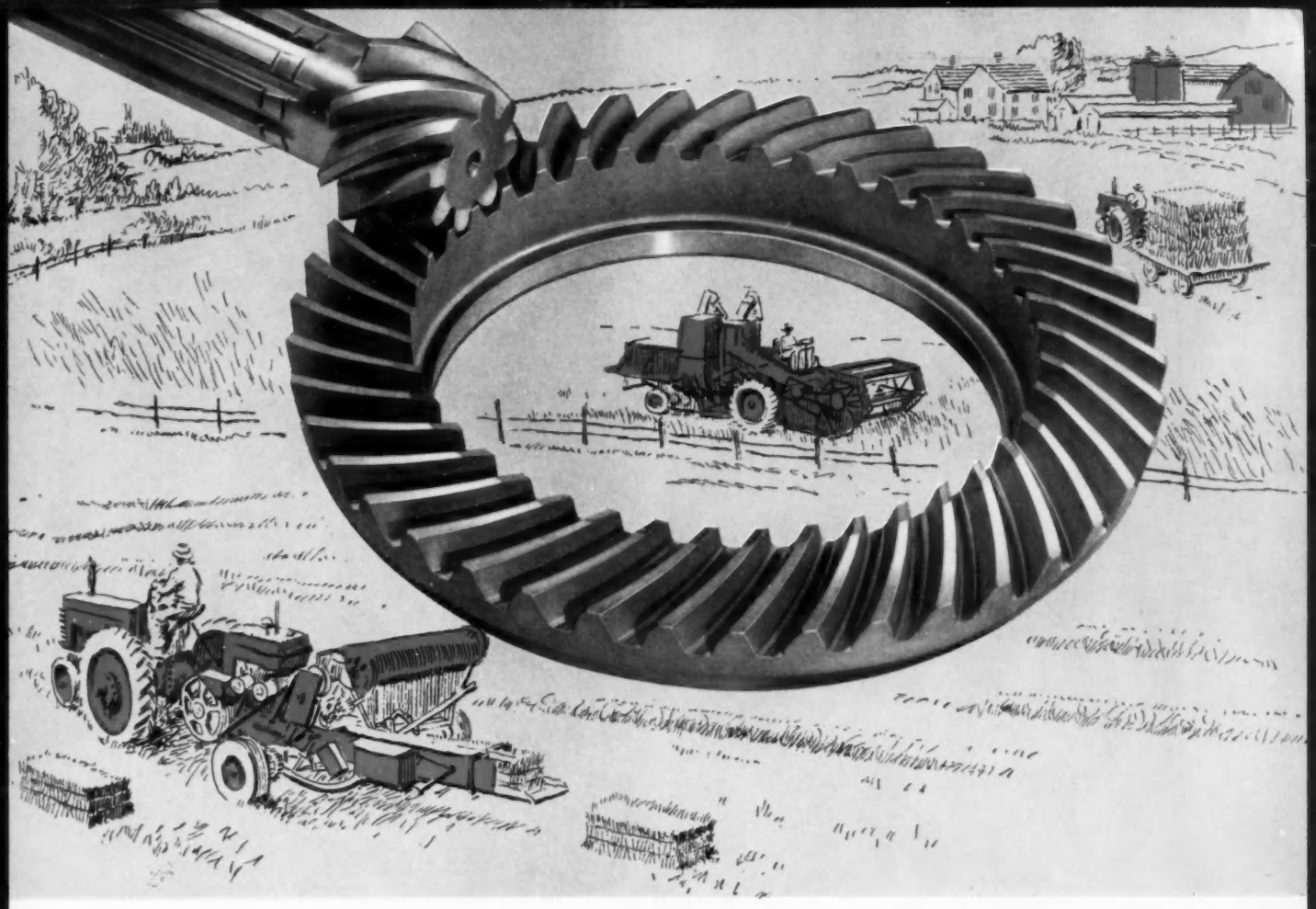

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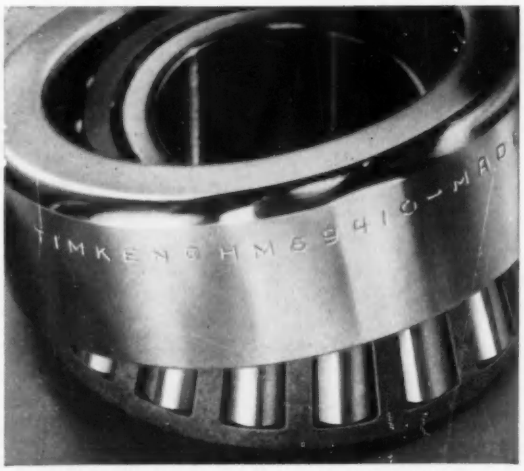

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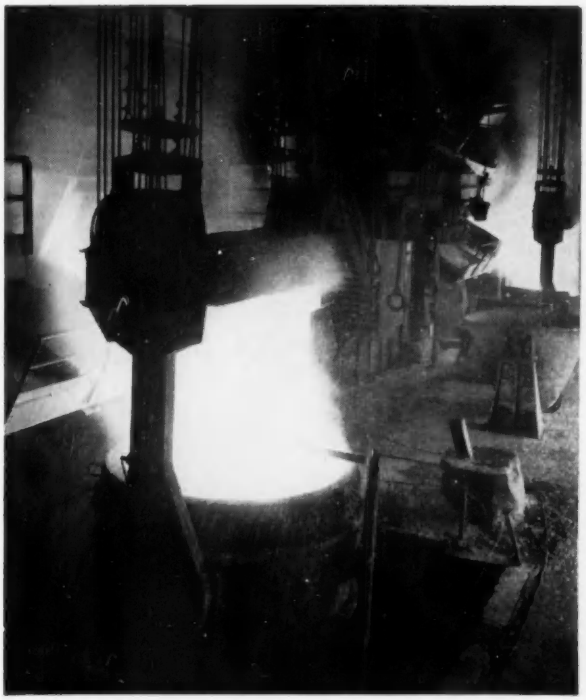

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